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A HUGE SUCCESS.

The N. E. L. A. Convention at Cleveland Largely Attended.

INTERESTING PAPERS, LIVELY DISCUSSIONS AND A GENERAL FEELING OF CHEERFULNESS THE PRINCIPAL FEATURES.

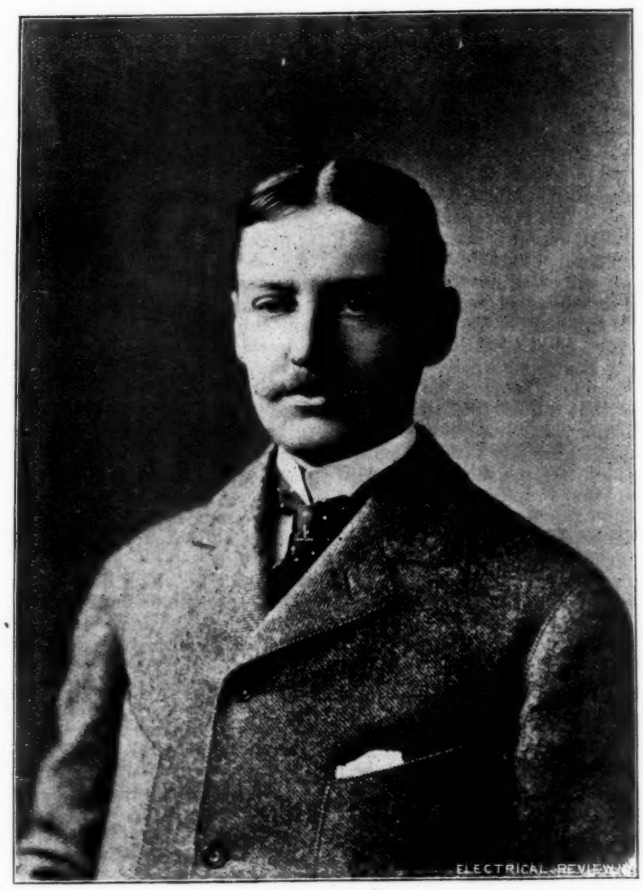
ONE OF THE MOST LARGELY ATTENDED CONVENTIONS ON RECORD—C. H. WILMERDING, OF CHICAGO, IS THE NEW PRESIDENT—FREDERIC NICHOLLS, OF TORONTO, AND E. F. PECK, OF BROOKLYN, ELECTED VICE-PRESIDENTS—NEW YORK IS PROBABLY THE NEXT MEETING PLACE, AND THE TIME WILL BE CHANGED TO A MORE SUITABLE SEASON, MAY OR JUNE.

The eighteenth convention of the National Electric Light Association, held at Cleveland last week, will go on record as one of the most successful of its kind. The attendance was unusually large, over 500 persons being present. The special train from New York carried 107 passengers, and three special cars brought a part of the Chicago contingent.

After the business dullness of the past year it was very encouraging to note the feeling of cheerfulness and hopefulness which seemed to pervade the meeting. A number of contracts, some of them considerable in amount, were closed during the meeting.

The electrical exhibition in the basement of the Hollenden Hotel was very creditable. Trips were made daily to various manufacturing plants in Cleveland. The General Electric Company had a complete monocyclic plant on exhibition in the Cleveland Illuminating Company's station, and the Brush Electric Company gave a public test of its new 125-light arc dynamo at its works.

The addresses were interesting and some of the discussions quite lively. Abundant entertainment was provided by the Cleveland local committee for the ladies attending the convention.



MR. C. H. WILMERDING, OF CHICAGO, THE NEW PRESIDENT OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

The reports of the secretary and treasurer showed the association to be in a healthy and well-managed condition, although ill-timed and pointless criticisms were made by Mr. John I. Beggs, of Cincinnati. The object of Mr. Beggs' strictures still remains a mystery, as no one could be found to whom he had confided what he was endeavoring to prove.

Taken as a whole, the convention was a huge success, and everyone who attended is doubtless glad he did so.

TUESDAY, FEB. 19—Forenoon Session.

The eighteenth meeting of the National Electric Light Association was called to order in Army and Navy Hall, Cleveland, Ohio, by President Francisco at 11 o'clock A. M., Tuesday, February 19, 1895.

The President introduced Hon. Robert Blee, Mayor of Cleveland, who addressed the delegates as follows :

I hardly think it would be proper for me at this time, as mayor of the city, to give the delegates full freedom of the city, as I have found from personal observation that they have already taken it. As mayor, however, I greet you, and extend to you a very cordial welcome to this, our beautiful Forest City. Our citizens are always glad to have citizens from other cities visit the metropolis of Ohio, and to feel perfectly at home while here with us. The latch-string of the city of Cleveland is always out for our friends from abroad. We have here a very large manufacturing city and a convention city. We have to-day with us the superintendents of the schools of the United States in convention assembled, and, taking them together with the electrical gentlemen and their ladies who are here present, we may have our hands full, but we will try to entertain you the best we can. The city is yours, and as Mayor of the city I extend to you its full freedom. I trust that your deliberations may be harmonious, and that you may figure

out a plan whereby you can light the entire business portion of our beautiful city with electricity at reasonable rates.

The president introduced Mr. James M. Hoyt, who said:

It is time for this association to meet here in Cleveland, for while Franklin, of Philadelphia, first harnessed the lightning, and Morse, of New York, made a winged messenger of it, and Bell, of Washington, endowed it with the power of speech so clear and penetrating that not distance, but only the telephone girl, could render it inaudible; and while Edison, of Menlo Park, made a mock echo of it, it was Brush, of Cleveland, who has made illumination of it, the beams of which are even now penetrating into the remotest corners of the earth, and while I talk the electric light is piercing the fog of London, shining on the boulevards of Paris and Vienna, glistening on the icy surface of Neva, and rending apart the mantle of darkness and throwing a kindly light over the horrors of the battlefields in distant Asia. It was at the commencement of the electrical world, as it were, that a citizen of Cleveland said, "Let there be light, and there was light."

A little while ago I visited a distant city with a party of gentlemen. We found it necessary to go from one side of the city to the other, and we took a street car to transport us. There were three cars in the train, and as we were nearing the end of our journey we went up quite a steep hill. One of the gentlemen with us, who had been looking around him with interest, said: "Gentlemen, the future of electricity no man can foretell or fathom. It is perfectly marvelous what electricity has done. Think of it drawing three loaded cars up this hill! I do not know how much we all weigh, but think of the enormous weight, and we are carried directly up a hill." There was a pause, when the critic of our party said: "Look out of the window; this is a cable road." [Laughter.] Although my friend used an unfortunate illustration, the fact remains—what the future of electrical development is to be, no man can tell. The possibilities are simply incomprehensible. Certainly 50 years ago, if anyone had foretold the telephone, the phonograph or electric light, I feel sure that the scientists of that time would have said to him, "That is simply impossible; it runs counter to the fundamental laws of nature." The idea of talking easily, without trouble, between Cleveland and New York; the idea of having a dead friend's voice reproduced; the idea of having this subtle and inexplicable substance, or fluid, or movement in the ether, or whatever you may decide to define it, light a large city, is ridiculous, and yet at the same time only a few years have rolled away and all of these results have been accomplished. In doing this, no natural law of nature has been broken; it has been simply the result of a knowledge on the part of the men who have made these applications of the forces of nature; of the laws of nature of which they were ignorant before. As I stand here and consider all the development that has already been made in electrical science, I must say there is a solemnity about it; and it ill becomes a scientist of this age, with the record of these tremendous achievements before him, to throw any doubt upon any mystery, whether it be physical, religious or spiritual.

I want to say again, as one of the representatives of the city of Cleveland, that we welcome you warmly and with open arms. We are delighted to have the city selected as a place of gathering for the representative men of this country, and there is no class more representative than the members of the National Electric Light Association.

The President introduced Mr. Charles F. Brush, of Cleveland, who was greeted with great applause. Mr. Brush said:

ADDRESS OF MR. BRUSH.

A few days ago I was asked to make some remarks on this occasion concerning the early history of electric lighting, strictly from my own standpoint. Now, as most of you are aware, I retired from the electrical business several years ago to give my competitors a chance in the field. [Applause.] I therefore objected that this ancient history was forgotten and buried and I pleaded that I could not spare time to take it up again and polish up the bones and arrange them in sequence and articulate them and make the whole thing presentable. I really cannot afford to let you go, now that you are here, and I will say a few words.

First Vice-President Frederic Nicholls, of Toronto, Canada.

Second Vice-President E. F. Peck, of Brooklyn, N. Y.

I will begin by calling your attention to the fact that dynamo-electric machines for electro plating antedated, by a considerable period, the use of such machines for lighting purposes. This is interesting from a historical standpoint, because when I invented compound field winding for constant potential, now so generally used in lighting and power transmission, I applied it first to plating machines. That, I believe, is not generally known and may, therefore, be interesting. Some of you will remember that all of the early Brush arc lighting machines were single lighters. Two of these machines were exhibited in the Summer of 1877 at the Franklin Institute, in Philadelphia. My two friends at the left (Messrs. Houston and Kennelly) will remember all about it. It was soon after that when we sold a single lighting machine to Dr. Longworth, of Cincinnati. This was one of the very first, if not the first, sale of a Brush arc lighting machine. It was late in 1877 or the very beginning of 1878; and the doctor paid for it—paid cash for it like a little man. I hear these things are done differently now. [Applause and laughter.] At any rate, I went down to Cincinnati to show the doctor how to run that machine, and one evening while I was there he exhibited the light from the balcony of the building in which he lived, on one of the principal streets. It was a 4,000-candle light, and of course it attracted a large crowd of the natives, and every man in that crowd was ready and willing and anxious to tell his neighbors all about it. I mingled in the crowd for a time to hear the comments. I found one man who had collected quite an audience about him. He called attention to the solenoid at the top of the lamp. He said: "That is the can that holds the oil;" and speaking of the side rod of the lamp: "That is the tube which conducts the oil from the can to the burner." He did not say anything about electricity at all—a little oversight that was not noticed by his hearers, and it was all right.

These early single-light machines were quickly followed by two and four-light machines; that is to say, machines adapted to furnish two or four separate, distinct currents, each adapted to run a single arc light. Several of these machines were sold during the season of 1878 for lighting stores and shops. Among others, Mr. Wanamaker, of Philadelphia, bought a number to light his store. One of the earliest of these four-light machines was exhibited at the works of the Union Steel Screw Company in this city to a number of invited guests. One gentleman on that occasion looked the whole apparatus over very carefully, perhaps a half hour, sized it up, and then, pointing to the line wire, he said to me, "How large is the hole in that wire that the electricity flows through?" [Laughter.] Another gentleman, one connected with the screw company, observed the machine running for perhaps five minutes in complete silence. Then he had fully digested the whole thing and was ready to tell me all about it. He said, "The electricity in that thing is generated by that revolving business there rubbing the air up against these iron blades (meaning the magnets), just as you get sparks when you rub a cat's back." I raised the objection that while that was a good theory, it did not fully meet the facts, but he would not hear anything from me. He said, "The whole thing is plain. If you should run that machine in a vacuum where there is no air, you could not get any electricity." His ignorance was so blissful that I thought it would be folly to enlighten him, and did not try to do it.

The year of which I am speaking—1878—was memorable in the history of electrical lighting. It was during that year that I had the great pleasure and good fortune to invent and develop and commercially introduce the modern series arc lamp with the shunt coil. It was this invention—I am sure you will all agree with me—which first made arc lighting from central stations commercially possible, and I think it may justly be considered as marking the birth of the electric lighting industry of the world to-day.

One of the first instances, I think quite the first instance, of the use of arc lighting for purely commercial purposes was in our little public square in this city. Twelve lights were carefully installed in the park on high ornamental poles. The lamps used were of the ordinary so-called 2,000 candle-power. In this connection it will be remembered that a professor in New York once said he imagined the electrical companies arrived at the 2,000 candle-power by measuring it North, South, East and West, giving 500 each way, and added them all together. That measurement was taken in the interest of the gas company, as I have learned. While we were installing this plant in the public square a great deal of interest was manifested in the installation by the public, and on the occasion of starting the lights, our little park was packed from side to side, and it was evident that many of the people expected a blinding glare of light, as evidenced by the fact that many of them had provided themselves with colored spectacles or smoked glass. Of course, there was a general feeling of disappointment at first in this respect, although everyone was ready to admit he could read with perfect ease in any part of the square. After a few weeks, when the novelty had worn off, and the people had got tired of staring at the arc and had time to see how nicely the little park was lighted, the general verdict was that those electric lights in the park were a pretty good thing after all; and that is the general verdict everywhere.

Of course we had lots of trouble in the early days with carbons. The history of the carbon business is peculiar. Our first carbons were crooked, of course, and were soft, and had high electrical resistance, and burnt out rapidly, and were very expensive. To decrease the electrical resistance and prolong the life of the carbons, we electro-plated them with copper, which is still done. This little scheme of covering the carbons with just enough and not too much copper was the only easy invention that it was my good fortune to make, and it paid fairly well, considering the effort involved, which was mighty small. It yielded, if I remember, something like $150,000 in cash on royalties before the bottom fell out of the carbon business. They were sold at the rate of $240 a thousand. I say at the rate of $240 a thousand because nobody ever thought of ordering a thousand carbons at once. They could not use them up in a generation. Fifty or a hundred were ordered at one time. As the business increased a little we were able to reduce the price of the carbons, and we did reduce it one step to $150 a thousand. It was at a loss for a time, but then we held our own and afterwards made a little money. We subsequently reduced them from $150 to $62.50, on the theory that cheaper carbons would stimulate the growth of the electric light industry, and our theory was proven correct. Their use was stimulated and the business increased enormously, so that while we lost money on the carbons for a good while at that price, later we made a handsome profit at that price. Others seemed to grasp the situation about that time, and competition sprung up, and it knocked the profits of the carbon business all to pieces. I presume now you can get your carbons for next to nothing a thousand, with "a beautiful chromo in each box;" and I have no doubt if you insisted you could get a nice gold frame with each of the chromos. This is a pointer for you.

As to electrical lighting at the present day, most of you know more about it than I do, for I have been accumulating rust for several years, and I will not attempt to tell you anything about it, but will simply thank you for your attention.

President Francisco then delivered the annual address, as follows:

ADDRESS OF PRESIDENT FRANCISCO.

Gentlemen of the National Electric Light Association: By the ceaseless revolutions of the wheel of Time we have arrived at another epoch in our association and meet to-day to celebrate our tenth anniversary and place a record upon the tenth page of our history.

Mr. Brush being the inventor of the double arc lamp now in use and the Brush Electric Company, of Cleveland, the first manufacturers of the same, it seems eminently proper that the National Electric Light Association should celebrate the present anniversary at the home of one of the pioneers in the field of electricity. We knew that the people of

the "Forest City" were noted for their culture, conservatism, industry and wealth, and the large number gathered here to-day afford sufficient proof of the wisdom of holding the eighteenth convention in this city.

Ten years ago a few men gathered in Chicago for the organization of a National Electric Light Association. How momentous the evolutions of science and what gigantic strides have been made in electric lighting during the short cycle of time that has since elapsed.

Millions of lights now

"Shine with holy oil that was never pressed
From olive tree in East or West;
That burn without a touch of flame,
A light beyond all light; the same
That guideth the feet of men, and still
Leadeth them on, wherever they will."

At the beginning of the present decade the association was represented by a few courageous men who believed in future enlargement and success, and the results far exceed the wildest dreams of anyone of that group. To-day we are an association whose members are numbered by hundreds, who represent the entire continent, from the Atlantic to the Golden Gate, and from the Gulf of Mexico to the Queen's dominions on the north. We have even invaded those dominions and appropriated one of her most loyal and enterprising subjects to serve as our second vice-president, besides reaching across 3,000 miles of ocean and securing the most talented of England's scientists. In addition to this, we have gained two faithful allies, the ladies and the press, the two powers that control the world. Such is our record of membership.

The financial progress is a marvel, even in this Nineteenth Century. The first arc lamps used required a separate circuit and a dynamo for each. After awhile dynamos were constructed to run two lamps, and when the time came that they could run four lamps from a single dynamo, it was considered a wonderful achievement. At the present time many stations are using as many as 120 arc lights on a single dynamo. With a nucleus of about 100 central stations in existence 10 years ago, we have to-day 2,500 such stations, representing assets of over $300,000,000, not including 7,500 isolated plants valued at $200,000,000 more. Ten years ago the total number of arc lamps could be counted in a moment's time, now they are like "Father Abraham's Army—500,000 strong."

The first central station for incandescent lighting was established in the Fall of 1882. The building was frame, one story, 15x18 feet, with a capacity of about 250 lights. Volt and ammeters were not in use, and the lamps were regulated by their appearance and the judgment of the station engineer. In case of trouble with the lights, the station was shut down and all hands turned out to hunt and repair damages; while this was going o , customers mused in the dark over the wonderful mysteries of electricity. That blessed time, with its indulgent customers, has passed into oblivion, and now the electric light manager has reason to think many times when accidents occur that Hades has been removed to his special locality, and very near his station. To-day we have single stations furnishing 150,000 lamps, and it would be almost as difficult to count the incandescent lights in use as to number the stars in the sky. In 1884 an experimental street railway was started in this city, using one car. To-day there are nearly 1,000 electric railways in operation, with 10,000 miles of track, and assets amounting to $600,000,000.

Thus it will be seen that electrical industries have caused an investment of over $1,000,000,000, not including the millions invested in telegraph, telephone, mining and etc. If the employés of these industries could be called together, they would dwarf the largest armies of the world.

Electricity has converted the thunders of Niagara, which have been aimlessly beating against its rocky shores for ages, to the uses of commerce, and will soon sound its reverberations over hundreds of miles of wire into distant cities, there to exert its mysterious power for the benefit of the busy toilers in their race for gold.

When this association was organized not an educational institution of high grade had a course of study in electrical engineering giving practical knowledge of electricity. To-day there are over 50 such institutions preparing the best young men of the nation to do scientific and practical work. American genius has proved of incalculable value to mankind and leads the world in electrical achievements. The members of this association should see to it that those who have developed this science occupy their rightful places of honor and receive acknowledgment for the wealth that their inventions have created. The benefits of their services are for all time, for future generations will continue the course we have begun, while human energy and force will go on forever. Zeus would admit that his prestige was gone and his thunderbolts harmless, if he could see Professor Thomson congealing iron and steel with the quickness of thought, or arcing a thousand ampere current; or, Edison bottling it up and sending its glow to light the paths of millions of people in every quarter of the globe; or, Tesla scattering it around loose, and even swallowing 100,000 volts in a single dose. It seems almost beyond human possibility or conception, yet nearly all of these developments have been made within the 10 years the National Electric Light Association has existed. There is only one parallel case in history, and that occurred about two thousand years ago, when the world was created from nothing in six days.

Have we not reason to congratulate ourselves that we are gathered here to-day as the representatives of these vast industries that have so revolutioned the civilized world? The beginning of electrical industries has been recorded on the pages of history. We cannot measure the limits of future developments, but if we are to judge by the records of the past ten years, what will the next decade show? Even those who have been the most active pioneers in the business cannot but stand aghast with wonder at the rush of the car of progress.

We may yet see electricity generated without the aid of steam, or the Empire State Express flying across the continent at the rate of 150 miles per hour; our letters mailed in New York in the morning read at the dinner table on the Pacific slope; the Electric Special, under an arrangement made by our master of transportation, may sail over the rugged peaks of the Alleghanies or the snow-capped summits of the Rocky Mountains, as we speed on our aerial voyage to the San Francisco convention; may even defy the laws of nature, germinating plants and fruit regardless of the sun's rays or its influence; no more ships crushed by polar ice as we fly across the wide expanse of ocean on our way to the long sought north pole; the wild Western prairies made to blossom like the rose by the aid of the electric plow and irrigator, while the electric reaper and thresher gather in the products that the electric train delivers in the far distant marts of commerce. Through its benign influence all mankind will be at peace; the Jap and heathen Chinee embrace each other, and the smiles of the Russian bear beguile the "sick man of the East." And, finally, it *may be* that the time *may come* when all it is necessary for an electric light man to do is to press the electric button, and the gold for which man has toiled for generations shall rush forth with a current of a thousand amperes.

A recent craze has been developed for "municipal ownership," and some aldermen of various municipalities have heard a rumor that there is one instance where something was created from nothing. Therefore, they believe that electric lights can and ought to be produced in the same way, especially if there is a prospect that the benefits to be derived from this style of production are to revert to themselves. This subject should have the careful consideration of the members of this convention.

Your Committee on Data have worked energetically, and I think their report will prove of great practical value to all our members. The papers to be read and topics for discussion embody the live issues of the day, and I trust will be carefully and thoroughly discussed, as in this way the practical knowledge and experience of men who have devoted their lives to the business is furnished to every member of the association, and in many cases may enable them to avoid the shoals and quicksands that have wrecked many electrical enterprises.

The membership and financial condition of the association never was in as flourishing a condition as at the present time, and your secretary deserves credit for his able and energetic work.

There is another subject that should receive immediate attention; that is, so amending the constitution as to arrange the time of the annual meeting at a more convenient, as well as a more seasonable, time of the year. Other rules relating to various plans of doing business should be changed to apply to our present style of work. Among the subjects that have had the attention of the National Electric Light Association since it was organized, none has called for more investigation and discussion than underground wires. I trust we shall have an able analysis of the subject at this convention, as it is a question of vast importance to many companies, and one upon which no company can afford the chance of a failure caused by improper construction or useless experiments.

The relations between central station companies and manufacturers have been discussed by this association at every convention. The time has arrived when the plan adopted by manufacturers for destroying the business of the local company, by establishing competing plants in places where there is only business sufficient for one, must be abandoned. This has been done with the intention of compelling the local company to either buy them off or see their own business ruined. The infamous scheme of forcing a sale of apparatus for a city plant, by representing to city officials that the price charged by local companies is far in excess of the cost if the city owned its own plant, needs the search-light of electricity thrown upon it by this association. This is a question of vital importance to every central station in the United States, for sooner or later their own business will be attacked, and it may be through the influence of the very manufacturer whose apparatus they are using.

During the past 10 years many who have met with us and taken an active part in the development of electricity have crossed the river that leads to the far-off shores of Eternity, there to await the coming of their fellow workers. They have won release from their labors, while to us remain,

"Pain of pleasures not yet won,
Pain of toiling not yet done."

Still in the bright Empyrean above us hang the eternal lights once set by powers invisible, to which we have added, where "Sable vested night once held full sway," millions of arc and incandescent lights that flash back their signal code,

"Hail, holy light, offspring of Heaven—first born."

The meeting then adjourned, a reception being tendered Mr. Brush and Professor Thomson in the room.

TUESDAY—Afternoon Session.

The meeting was called to order at 2.30 o'clock, and Nelson W. Perry read a paper on "The Storage of Energy Essential to Central Station Economy." It appears in full elsewhere in this issue.

Prof. W. M. Stine: It is well known that Europe has far excelled America in the development and applications of the storage battery. But a change seems to be occurring. The storage battery is rapidly becoming an important factor in the economics of electrical engineering. But since a widespread interest in the use of accumulators has become a factor it is necessary to regard the question of their economy from the cautionizing standpoint. It is well to recognize that the American storage battery is at present insufficiently developed to meet this demand. There is scarcely another class of electrical apparatus which involves so many intricacies and where the chances for success or failure are decided by such small margins. A storage battery plant, when it fails, fails so completely and involves such a relatively great expense that it would seem only thoroughly competent men should be employed in their development and applications. An accumulator plant must be intelligently and judiciously cared for. Its efficiency at best is low, and should the charge or discharge be continued too long the total efficiency is greatly lowered. The accumulator is not automatic in its action in the same sense that a transformer is, and requires constant inspection and testing, and supervision as well, when in action. The saving which it will effect at the coal pile is offset by the price paid for an attendant, and this factor must not be overlooked when estimating its economy. The cost of attendance is relatively high for small plants. During charging the current must be regulated so as not to exceed a certain maximum, and since the tendency on charging is to decrease the current it must be frequently regulated to hold it at the proper strength. The battery itself should be inspected at intervals during charging to detect excessive gassing and unequal action of the individual cells. Stress should be placed on looking after each cell rather than paying attention to the battery as a whole. A good practice is to wire each cell to a circular switch connected with a reliable voltmeter. In this way the voltage of each cell can be readily taken and a bad one located. It is not sufficient to take the volts at the ends of a series during charging as an indication of the extent of charge. A sulphated cell may cause a large drop owing to high internal resistance; the connections, when badly corroded, absorb a relatively great drop. These two causes may make the main voltmeter indicate the termination of the charging, when, if the voltage of the cells was taken separately, the charge would be found to be far from complete. The separate voltage plan is then a check on such faults as bad connections and poor cells, and will call attention to their existence so they can be remedied. As the electrolyte evaporates or is lost through gassing it must be frequently renewed and brought up to the standard density. The hydrometer is a piece of apparatus that must not be forgotten in the installation of a plant. There is always danger that the small pieces which become detached from the plates will cause a short circuit. Again, to prevent this a narrow strip of thin rubber should be run between each pair of plates. During the discharge the attendant should see that the discharge capacity of the battery is not exceeded, for if this occurs frequently the plates will be damaged. As the discharge proceeds the voltage must be taken over each cell to prevent the weaker ones from over discharge. No matter how excellent the battery may be it will need frequent repairs, and such repairs are not only tedious, but take a great deal of time. This consideration must be allowed for in installing a plant or it will result in disappointment.

A dynamo is most efficient when working near its raised capacity; the accumulator is not. The lower the rate of charge and discharge within certain limits, the higher will be the efficiency. Trade competition has led to a large over-rating of cells. The ordinary 300-ampere hour cell will show the best results and most economical life if worked to only 75 per cent of its rated capacity. In the main this is true for all sizes, unless the maker has rated his plates especially low. If worked too high a too large proportion of the plate is converted into active material, and in time much of this active material will scale off and fall to the bottom of the cell. The body of the plate, too, will become soft and spongy and completely fall apart. Experience has shown that this action is not confined to any particular form of plate, but seems inevitable at some period in the life of all plates. If a plate is abused it soon makes its appearance; if properly cared for it comes only after a long and useful life. It is a matter that should be carefully looked after, for if detected before the softening has gone too far it may be partially remedied. The soft plate should be removed, washed thoroughly and dried, then worked as a negative and reduced to spongy lead, when it is in a condition for reforming. Built up in this manner it can be restored to its place in the cell. European experience has shown that it is possible to reach an efficiency in watts of 75 or 80 per cent. At present a good cell should show an ampere efficiency of at least 90 per cent. These are certainly good results, but would seem capable of improvement.

At present it seems as if central station managers would not install a storage battery plant unless the life of the plate be guaranteed by the maker. This seems to be an unfair demand, unless the manager in turn guarantees the quality and extent of the attention to be given to the plant. A good cell may be ruined by injudicious as well as careless treatment, and the margin between proper care and unfair treatment is so narrow that such questions would involve endless complexity and litigation. It is only fair to the manufacturer that he guarantees his cells to be fairly uniform as regards capacity and efficiency, and the question of life be left with the purchaser, unless poor construction become evident in the life of the battery. In order to properly discuss the probable increase in efficiency it must be borne in mind that an accumulator is primarily a chemical device, storing chemical rather than electrical energy.

The considerations in selecting a battery for central station or power may in part be summed up as—

1. Plenty of lead in the elements. One maker places the quantity at two ampere hours capacity per pound.
2. Ample storage capacity for the work to be exacted from the battery. This should rather be over-estimated.
3. The plates should be well separated, and easy of access for cleaning.
4. The mechanical strength of the plates should be able to withstand all charging strains.
5. The plates should be free from all soldered joints and the metal should be homogenous.
6. The plates should be free from points that may be especially weakened by local action.
7. The active material should be so disposed that it may have the freest possible access to the acid.
8. The active material should be so thoroughly attached to the plates that it will not readily fall off in use.
9. The separate plates of an element should be so attached to the connecting bars that they may be readily removed for inspection or repair.

Herbert Lloyd, of the Electric Storage Battery Company, Philadelphia: Of the five methods of storage which Mr. Perry has considered, I would call your attention to the figures which are supposed to show the results obtained from electro-chemical storage. For the purpose of this discussion I will take it for granted that the figures given on the first cost of boilers, engines, dynamos and buildings are correct up to page 8, also for the maintenance of the same, but I most decidedly take issue with the figures given on pages 8 and 9, on the first cost of a plant half storage and half direct, also on the cost of maintaining the storage battery and the amount of coal consumed in charging the same. On page 8 of the paper just read the author gives the total investment without storage battery as $306.80 per horse-power. The first error is in assuming that all the energy generated is stored. He assumes a loss of 25 per cent of all the energy generated, but as only half is stored, the loss should be but 12½ per cent of the whole. Instead of dividing by .75 he should have divided by .875, which gives the total cost of the machinery as $155.42 instead of $181.80. Next, as to cost of buildings: Taking the buildings at $30, as in previous cases buildings without battery would cost $53.04. Adding 25 per cent to this, which is very liberal, for battery building, we get $68.30, or a total of $223.72 instead of $306.80. Next comes the cost of electric storage battery, which is given $35 to horse-power erected, or $420 for 12 horse-power hours which would be necessary if the plant was half direct and half storage.

Where such figures could be obtained I am at a loss to understand. About 50 per cent has been added to the real cost. A battery plant can be erected to-day for $24 a horse-power hour, which would give a total invest-

ment for a plant half storage of $223.72 plus $288, or a total of $511.72 instead of $726.80, as given.

It would be readily seen how the decreased interest charge will affect the final result.

Next as to maintenance of storage battery. ten per cent on the total investment of a central station battery plant is unheard of. ten per cent on the price of the lead plates is the highest maintenance contract which has come to my attention, and this would about correspond to six per cent on the first cost of installation. So, instead of 10 per cent on $420 as a maintenance cost, we have but six per cent on $288 as an actual fact.

Again, in estimating the amount of coal consumed for electrical horse-power, Mr. Perry gives for steady work a coal consumption of 2.21 pounds. If charging batteries does not give regular load, I would like to know what does, and yet he gives the coal consumption for charging batteries at four pounds.

By substituting corrected battery figure for those quoted by Mr. Perry, we have the following results:

Batteries at $24 per electrical horse-power hour.	
Total investment, plant	$223.72
Battery	288.00
	$511.72
Interest at 4%	$20.47
Maintenance and depreciation	
Buildings at $68.30 at 2%	1.37
Machinery at $155.42 at 7½%	11.66
Battery $288 at 6%	17.28
Total fixed annual cost	$50.78
Coal 2.21 pounds for 8,760 hours at $1.75	$16 93
12½% additional for loss in battery	2.11
Petty stores and attendants	13 37
Total annual cost per E. H. P.	$83.19

Batteries at $24 per electrical horse-power hour; coal at $1.75 per ton:	
Steady load without electric storage battery	$48.68
Variable load made steady by battery	83.19
Variable load without battery	117.78
Saving with electric storage battery	34.59
Coal at $3.50 per ton:	
Steady load without electric storage battery	$65.62
Variable load made steady with battery	100.12
Variable load without battery	148.41
Saving with electric storage battery	48.29

Mr. Perry's figure of $52.31 with steady load without storage battery is evidently an error in figuring, as it should be $65.62, as I have stated. To sum up, comparing the results of the various systems, we have the following:

Coal	$ 1.75	$ 3.50
Storage battery	34.59	48.29
Gas engine	29.50	44.79
Feed and steam storage	23 36	37.05
Feed storage	20.20	30.82
Steam storage	00.06	13.63

It will be seen that correcting the battery figures has changed the result from $13.43 and $13.34 to a saving of $34.59 and $48.29, respectively. I would state that the figures given on gas engine methods are, in my opinion, far too favorable to the gas engine for central station work when based upon results obtained in this country. The units are necessarily small and the speed comparatively high, making the cost of labor, maintenance and depreciation much higher than would be the case were large steam engines and generators used running at low speed. By correcting the figures on the first cost of battery—and the figures that I have given cannot be disputed—the situation acquires a new aspect. Instead of the application of a storage battery resulting in a loss of over $13 per annum per horse-power, we have a saving far above that shown by any other system—in fact, about 50 per cent greater than the saving shown for combined feed and steam storage.

The Edison Illuminating Company of New York is just installing a battery of nearly 2,000 horse-power hours capacity, and it is mainly upon this contract that the figures given above are based. In the exhibition room over in the hotel one of the cells about to be installed is on view, which has a capacity of 4,000 ampere hours, having a discharge rate of 1,000 amperes for between three and four hours.

Mr. Perry touches very lightly on the great utility of a battery to be discharged in from one to three hours as applied to taking the peak of the evening load. I learn from many large station managers that one and one-half to two-hour battery is what they most need, and when it is borne in mind that a battery of this character costs to install but about $50 per horse-power, the situation acquires entirely new aspects. A direct plant, including boilers, engines and dynamos of the most durable and approved machinery, will cost certainly from $60 to $75 per horse-power, and I think the fact that storage battery can be installed, worked at one and one-half to two-hour rate, for about $50 a horse-power certainly brings electric storage to the front. Mr. Perry is mistaken when he states that at rapid discharge rate the battery is less efficient than 75 per cent. This can be readily proved and is being demonstrated every day. Not only is the first cost of storage battery brought within the reach of central station operators, but the depreciation can be kept down as low or lower than the depreciation of any other machinery which can be installed.

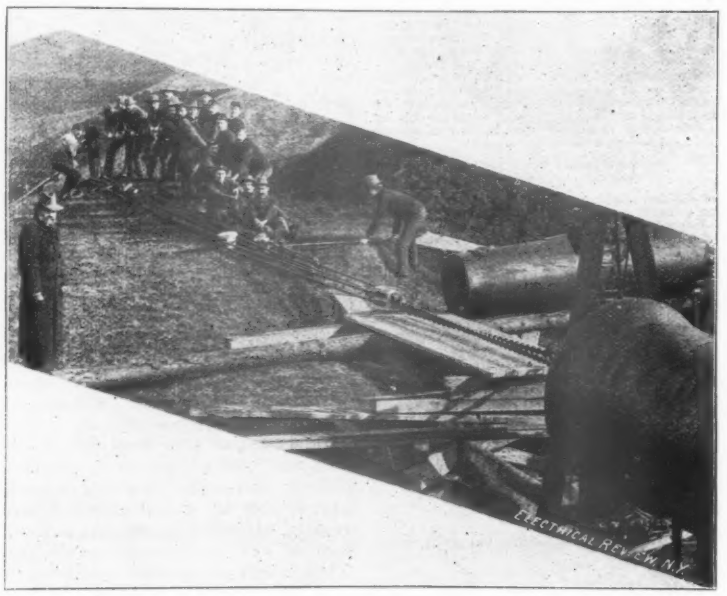


FIG. 1.—THE GREAT GUN MAGNET.—ATTRACTION TEST AT WILLET'S POINT, N. Y., BY COL. W. R. KING.

Those of you who were in Washington a year ago will probably remember a description read of the central station battery installed in Germantown, Philadelphia, the previous year. I am glad to be able to state that that battery has been in constant and successful operation ever since, and up to date has not cost the station nor the battery manufacturing company one dollar for repair. In the room can be found a paper describing a more recent installation of a battery in the city of Merrill, Wisconsin, where it was applied to both railway and lighting circuits. This battery has a capacity of about 325 horse-power hours, and its effects as a regulator both on the light and power circuits are very strikingly shown in the diagram attached. I may also state that the cost of this battery is covered by the figures quoted above. As the Germantown battery, the Merrill battery, and the one about to be installed for the New York Edison company cover all the central station batteries which have been as yet contracted for, with the exception of a foreign battery installation in Boston, the prices obtained for the different plants are the only ones on which estimates can be reliably based. Anyone taking the trouble to have asked for information from the manufacturers would have been afforded every facility for obtaining the exact and reliable figures.

Mr. Seely: Some years ago I was connected with a company which installed a storage battery plant of 600 cells. I think at that time it was the largest plant in the United States. The cells cost $14 each, or $8,400 for the entire plant. When they came to erect the plant it cost probably $2,000 more to connect it up with various appliances. It required two men at $2.50 a day to pay particular attention to each cell, and the renewing of the plates was about $500 a year, which made the cost of maintenance about 28 per cent on the investment. I regret to say that the battery was discontinued after giving it a two-year trial.

Mr. Lloyd: The fact that it required 600 cells shows its character. We can now do the same service with 60 cells.

Mr. Seely: I would like to hear from some individual, a member of this association, operating storage batteries. I do not say there is not a good storage battery to-day, but I would like to see it demonstrated.

Mr. Wright: The Germantown battery was installed during January, 1894, and was put into regular service on February 4, 1894. It supplies current to the 220-volt three-wire direct-current mains furnishing electrical energy for incandescent light and power. It is in operation from dawn to dusk of every day. It has been in continuous use from the last mentioned date until the date of writing, with the exception of July 29, when the entire battery was dismantled and a complete set of new wooden separators put in. The wooden separators originally installed were made of poplar, and it was found after nearly six months' trial that the acetic acid in this wood combined with the lead, forming acetate of lead, which tended to weaken the battery by discharging locally. The new separators are made of cherry, and after over two months' service it is found that they do not give the trouble experienced by the use of poplar ones. The Germantown battery is put into charge during the evening after the load has dropped somewhat, and when fully charged, which is done in from five to seven hours, is allowed to stand until the engine is stopped in the morning. The battery is then put into circuit, and feeds the line until dusk, when the engine is started again. It has been shown repeatedly, when the battery has been allowed to stand over night without charging, as is occasionally done, that the quantity of fuel used is not appreciably decreased. It is necessary to say, however, that this is primarily due to the fact that the charge is usually a very small proportion of the total load of the engine. If the charge was a large fraction of total load of the engine, there is no doubt whatever that it would take its proportionate share of fuel. In this Germantown case. however, the conditions were such that the day circuit, when run by steam-power, was costly from the very fact that the output was so small. Now that the battery taxes the day circuit, although the output has increased at least 25 per cent, it does not now average over 50 amperes, or the equivalent of 100 16 candle-power incandescent lights burning. Careful hourly readings of electro-motive force, current and specific gravity have been taken on this battery from the time of starting up.

Those figures show that up to the time of changing the separators, February 2 to July 28, or nearly six months, the watt efficiency was 82.6 per cent. These figures include the first charge for which some allowance ought of course to be made. The figures from July 30 to October 7, inclusive, over two months, give the watt efficiency 74.2 per cent; ampere efficiency 86.6 per cent. These latter figures represent the true efficiency and are very much better than the writer expected. He allowed 35 per cent loss when estimating results prior to the installation of this battery. The writer has again gone over the figures relative to the saving accomplished by the use of this battery. You will remember that before installing the first small battery at Germantown tests were made to find the actual cost of operating day circuit by steam power. It was found that the operation of the day circuit cost $3,615.15 per annum. The saving by the use of the battery is made up as follows:

One man at $10 per week	$520.00
Half one man at $7.50 per week. This man now spends half his time trimming additional arc lamps.	195.00
Fuel, 582 tons at $1.85	1,076.70
Water, 300 M. at 60 cents	180.00
Oil, waste and sundries	100.00
Depreciation and repair on plant now idle, value $8,000, at five per cent	400.00
	$2,471.70
Less depreciation of battery (est.)	600.00
Net saving	$1,871.70

Besides the above, we hope to be able to put the battery to help out the dynamos during the night run. Tests have been made recently to ascertain to what extent this can be done.

Mr. Nicholls: I would like to say that, so far as the Germantown system is concerned, at that time it appeared to me that the day load, which is such an important feature in the use of the storage battery, was practically negligible. So far as I am aware the only two practicable systems in central stations in this country are in New York and Boston, respectively. I believe Mr. Edgar, of the Boston Edison Company, is present, and I am sure we would like to hear from him.

Mr. Perry: I was not able to catch specifically all of the criticisms that were made as to my figures. The statement is made that I have charged too much for the depreciation of storage batteries, which is put at 10 per cent, and too much for the batteries. As to the cost, Unwin puts it at £8 per horse-power hour storage capacity, or $40. Professor Forbes puts the figures at about the same for English practice. I thought I was safe in putting it at $35. In regard to my charges for energy lost, I have put it at 25 per cent. With 12 horse-power hours stored, 25 per cent of that would be lost if the efficiency of the battery were 75 per cent. That I have charged and nothing more. I have distinctly

(Continued on page 106.)

THE GREAT GUN MAGNET.

INTERESTING DATA AND ILLUSTRATIONS FURNISHED THE "ELECTRICAL REVIEW" BY COL. W. R. KING, U. S. A.

TO THE EDITOR OF ELECTRICAL REVIEW:

As requested by you some days ago I send you herewith three views of the gun magnet and the following condensed data relative to it:

Weight of gun, 50,000 pounds. Length, 16 feet. Coils extending eight feet. Cross-section 300 to 1,500 square inches. Material, cast-iron. Length of wire, about 10 miles or about 5,250 turns, which, with a current of 21 amperes, gives over 110,000 ampere turns. Maximum pull, 44,800 pounds; the magnetic circuit being completed by a pile of wrought-iron plates. Projectiles, 320 pounds each. The armature had a cross-section of 131 square inches.

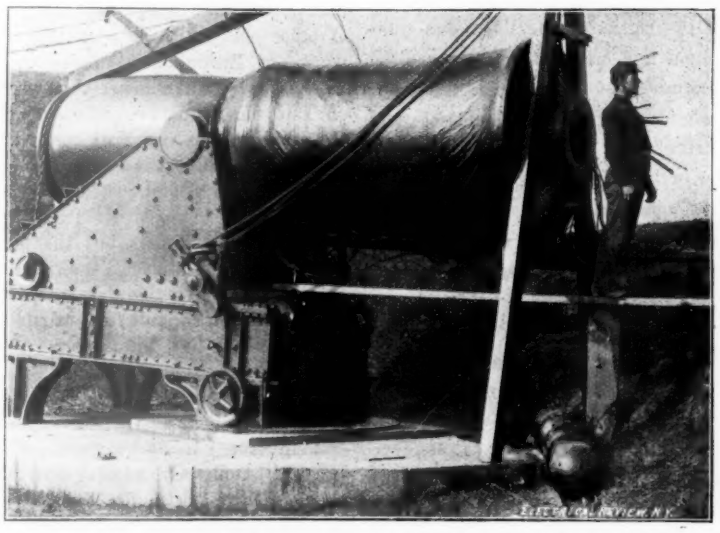


FIG. 2.—THE GREAT GUN MAGNET.—ATTRACTION THROUGH A SOLDIER'S BODY.

At a distance of about 71 feet from the muzzle the field created by the magnet is equal to the earth's field, while at one foot from the muzzle it is about 338,000 times as strong as the earth's field.

From a series of measurements at different distances the deflection of the needle has been determined, and from these results an empirical formula has been deduced, giving the tangents of the angles of deflection as a function of the distance as follows:

$$y = \frac{2.7}{x^3} + \frac{.2}{x^2},$$ in which y is the tangent of the angle of deflection and x the distance in units of 50 feet.

It is well known that the law of inverse squares does not apply to magnets, except theoretical ones in which the poles are physical points and are at a very great distance apart.

The deflections of the needle at distances of 50, 100, 150 and 200 feet were found to be 71°, 19½°, 6° and 3°.

Further measurements of this kind are to be made as soon as the weather will permit and the lines of force are to be plotted at a much greater distance than they were carried on a former occasion.

It has been found impossible to detect any physiological effect of the magnetic force, and tests of its effect on light and sound have been, thus far, of a negative character.

Very respectfully,
W. R. KING.

Willet's Point, Queens Co., N. Y.
February 18, 1895.

The Inventor: His Methods and Remuneration.

"Inventors seem very much alike as a caste. They talk loudly, especially about 'conspiracies of monopolists;' they beat upon the table with their fists; and they secrete fragments of their inventions about their persons." In this way does Mr. Rudyard Kipling express matters in one of his "Plain Tales from the Hills;" and we are not sure, says the London *Electrical Review*, that he does not succeed in approximating very closely to the truth, until on further consideration it appears that the vagaries of individuals often obscure the sterling qualities of the class and hinder a just judgment from being formed.

In contradistinction to Mr. Kipling's views, we have Mr. Eustace Carey, the chairman of the Liverpool Section of the Society of Chemical Industry, dividing the genus inventor into several well-marked species or groups. There is, first, the practical manufacturer who, with command of capital, experience and the assistance of experts, works out a new idea to a finish, ending in its adoption or definite abandonment. He is typical of a class of inventors who, when they possess capacity and perseverance, cannot fail to be of great service to the community. But even men of this class, and celebrated men, too, have not been able always to restrain themselves from the weakness of inventors of a commoner type; they have, parenthetically, as it were, run to the Patent Office to secure the protection of immature notions and half-fledged ideas which have occurred to them during their work on the main and particular invention which they have had in hand. In fact, the very best of inventors, however practical and experienced they may be, seem to be sometimes victims of a disease which may not, inaptly, be termed inventors' mania. The spirit of invention invades them. Ideas, good, bad and indifferent, seize upon them, till writing specifications and paying patent fees becomes an almost daily excitement, without which life seems to them flat and uninteresting.

Manufacturers and capitalists, who belong even to the best class of inventors, are not always an unmixed blessing to their partners or to the firms to which they belong. They are apt to pursue will-o'-the-wisps and to neglect steady attention to everyday business or common place improvements. A manufacturer or managing partner of a works who has his eyes open to perceive the small additions or alterations which may improve or cheapen production, and has also his mind open to accept suggestions from his colleagues and his workmen as to the never-ending improvements which can be made in details, is frequently a wiser man than his compeer who has a genius for revolutionizing everything. An inventive partner often gradually becomes a perfect terror to his friends.

There is another class of inventor, comprising those who are not engaged in manufacture, some of them men of sound scientific knowledge and possibly of some technical experience, but who cannot afford themselves to make a large scale experiment, or cannot create a value for an invention by the expenditure of sufficient capital. So they call in an expert. They want a large sum for the invention and hence their next step is to interview a company promoter. Presently the inevitable prospectus makes its appearance, embellished with "the favorable opinion of a well-known scientific expert," who solemnly states that "from the interesting and successful experiments which he has been permitted to witness and from a careful examination of all the conditions, and assuming that the large scale results bear out the experimental trials, which he sees no reason to doubt, then the prospects of the company are brilliant in the extreme."

One of the most tiresome types of inventors is he who is unwilling to take any further risk of his invention but demands from the practical manufacturer to be at once remunerated to the full value of his own estimated profit to be made in the unexpired portion of the 14 years' life of his patent. Now, while it is difficult to fairly guess the possible profit to be gained by an invention, it is still more difficult, well nigh impossible, to capitalize it. To make such a venture, except at very short purchase, say two or three years, is almost equivalent to gambling, if a company be formed to acquire the new patent and a large amount be paid in cash. If, in a manufacture, finality could be reached and a certainty thus arrived at that the patent to be acquired would not be superseded in the course of a few years, such payments to inventors might be justified; but when we remember that a money-making invention is just the one to attract the attention of inventors all the world over, the payment of a large sum is unwise. Most inventors insist on a payment of a certain amount of cash. The most prudent are those who are satisfied with a small amount and are content to accept a share interest in the venture.

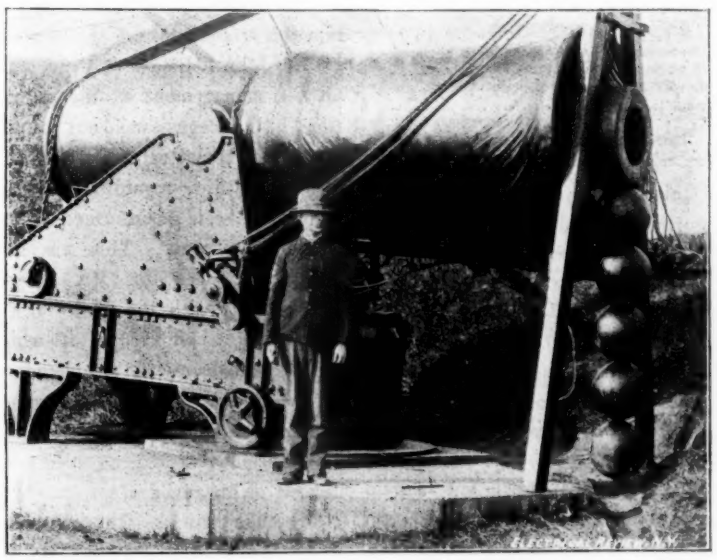


FIG. 3.—THE GREAT GUN MAGNET.—SUSTAINING FIVE LARGE CANNON BALLS.

That type of inventor, the dealer in secrets, is a power in the world, too, since it is a common weakness of human beings to be charmed by the unknown, almost in direct ratio to its approach to the impossible, as witness electric sugar. Whenever a thing is to be kept a secret until a purchaser has satisfied himself that it will work, we might almost at once dismiss it, for if it is a patentable invention there is no secret necessary, and if not patentable, there is no guarantee to the purchaser that the invention may not be worked by others.

Having mildly pilloried the chief types of inventors, it behooves us to say something respecting the direction in which a man, desiring to place something new before the commercial world, should seek his due remuneration. We may at once leave out of consideration the members of our first group of inventors; viz., those who are capitalists and manufacturers, since they will work out their ideas in their own way and for their own profit, as is, of course, becoming. The remaining groups may be taken *en masse*, since they really resolve themselves into a set who have not the means with which to exploit their notions. Sometimes—and, indeed, very often—these are mere outsiders, or to speak more euphemistically, laymen; more frequently they are the employés of manufacturers. These, it seems to us, should look to reasonable royalties for their rewards, unless they are prepared to accept a small sum to re-imburse them for their preliminary outlay, followed by a moderate share interest in the company that is formed to run their invention. If this plan were more uniformly adopted, one of the causes of overcapitalizing would be eliminated and the venture would be more likely to enjoy commercial prosperity.

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CHARLES W. PRICE.
ASSOCIATE EDITOR:
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Quietly, but steadily, business is improving in industrial circles.

Street railway men have the next call on conventions. The annual meeting of the American Street Railway Association assembles at Montreal next October.

The next convention of the National Electric Light Association should certainly be held in New York city, where the opportunities to combine business and pleasure are unsurpassed.

The convention number of the ELECTRICAL REVIEW was the first electrical paper to reach Cleveland. The advance guard of delegates welcomed the paper Sunday noon. Our contemporaries commenced to arrive on Tuesday.

THE NATIONAL ELECTRIC LIGHT ASSOCIATION'S EIGHTEENTH CONVENTION.

"A complete success" is a fit phrase with which to describe the 18th convention of the National Electric Light Association held at Cleveland last week. The members were fortunate in hearing an address delivered in a conversational manner by Mr. Charles F. Brush, who on this occasion made his first appearance as a speaker before the association. Dr. Bell's paper on the monocyclic system was interesting, chiefly on account of the lively discussion it provoked. The other papers were good, too, and were well discussed.

The attendance was large, over 500 people being present. The exhibition of electrical apparatus was instructive if not large. The local entertainment was of a character to express the hospitality of Cleveland's citizens, and the delegates were afforded opportunities to visit the city's principal manufacturing industries.

The association honored itself and the Cotton States and International Exposition by passing the following resolutions, as outlined in these columns last week:

Whereas, the Cotton States and International Exposition is to be held at Atlanta, Ga., from September 18 to December 31, 1895, and

Whereas, the United States Government has recognized this Exposition and has appropriated a considerable sum of money for a government exhibit, and

Whereas, the Exposition Company has provided a large Electricity Building to be devoted exclusively to exhibits of electrical apparatus, inventions and kindred interests, therefore be it

Resolved, that the National Electric Light Association in its 18th Convention assembled, hereby urges its members to attend the Cotton States and International Exposition, and to avail themselves of this opportunity to exhibit electrical products especially devoted to the electric lighting industry in the Electricity Building set aside for that purpose.

The only thing that occurred to mar the proceedings was the criticism of Mr. John I. Beggs, of Cincinnati, on the management of the association. Mr. Beggs was out of his depth in this matter and was talking about something regarding which he had either been misinformed or was entirely ignorant. This was only natural in view of Mr. Beggs's unfamiliarity with the affairs of the association, a knowledge of which can be gained only by attendance at its meetings. Whatever his object was, it was apparently defeated and his position reflected no credit on himself or his advisers.

The ELECTRICAL REVIEW takes this opportunity to congratulate the National Electric Light Association on its present flourishing condition and to say that we believe this condition is largely due to the able and untiring efforts of Secretary George F. Porter, who has uniformly had the support of the executive committee ever since he has been in office.

TELEPHONE LEGISLATION.

The agitators who have been demanding a sweeping reduction in telephone rates by legislative action met with an emphatic set-back at Albany last week. At a hearing before the Senate Committee on Cities and the Assembly Committee on Gas, Water and Electricity on the so-called Gerst-Persons telephone bill, arguments against the bill were made by counsel for the various telephone companies. The salient result of the hearing was to show that the bill had been drawn with a reckless disregard of the rights of the telephone companies and with the most appalling ignorance of established telephone practice in different places, and further, that the working provisions for giving it effect were so ridiculously inadequate that its passage would practically mean the confiscation of the business of the telephone companies.

We have not the space to reproduce in detail the able and exhaustive arguments of the opponents of the proposed measure, but suffice it to say that so thoroughly did they riddle the bill itself, and so effectively did they rebut the arguments of its supporters that before the hearing was concluded Mr. Simon Sterne, the real author of the bill, had to ask for an adjournment in order that he might provide amendments to meet the various points that had been raised. The hearing was, therefore, adjourned for two weeks to give Mr. Sterne an opportunity to prepare a revised version of his bill.

We cannot but remark that when attempts at legislation are based on such absolute ignorance of the business affected as has been shown by Mr. Sterne and his associates they cannot escape overturn when met by arguments based on facts and on actual experience. If any study of the telephone business had been made by the supporters of the bill they could never have fallen into the amazing blunders that the bill contains nor would they have risked making the absurd misstatements that occur in their arguments. A very modest amount of technical knowledge—that he might easily have acquired during the four or five years of posing as a telephone reformer—would have convinced Mr. Sterne that some of the facts which he disputes are as well established as any of the fundamental rules of law that guide him in his own profession. A quite insignificant amount of time devoted to inquiry in the proper quarters as to the conditions of the telephone business in the different European and American cities that he visits so frequently would have made clear to him the reasons for the superficial differences in rates that he quotes so glibly.

For instance, in the course of his argument for the bill Mr. Sterne cited various European cities where the telephone rates are lower than in New York; he insists that the only item of cost of furnishing service that is cheaper there than here is labor, and he urges that it is monstrous to pretend that the operating expenses of a telephone company increase even in direct ratio to the number of subscribers.

The facts are—and we give them on excellent authority—that there are many conditions other than the cost of labor that cause the operating expenses of European telephone companies to be much lower than those of American companies, and especially than those of the New York company. In no European city is there a general metallic underground system such as that of New York. In Paris the wires are underground, but the telephone administration has the free use of the sewers for their accommodation. In Berlin they are partially underground, but the system is a radically different one from that adopted in New York, immensely more economical, while, of course, less effective. In Berlin there are 37 miles of telephone duct as against 700 miles in New York. In Vienna the wires are partially underground, but they are laid in rubber cables buried directly in the earth, an archaic method that American telephone engineers would not dream of adopting. In London the wires are almost entirely overhead. Both in London and in Berlin the systems are grounded circuit, and in Vienna they are partially grounded circuit. The wire used for local line construction throughout Europe is phosphor or silicium bronze, weighing about 40 pounds to the mile. The use of this light wire results in very cheap line construction and maintenance, and the general use of grounded circuit systems necessarily means comparatively cheap central office construction and maintenance.

It can very readily be seen that the difference in systems entails very large differences in operating expenses. The cost of maintenance is necessarily much less for a single wire overhead system than for an underground metallic circuit system, and taking into account the cheaper rates for labor in Europe, it is found that, for a given number of subscribers, the European telephone companies spend in all departments from 20 to 25 per cent of the amount that the Metropolitan Telephone Company spends for different classes of labor.

Therefore, leaving on one side entirely the question of the quality of the service and the facilities enjoyed by the subscribers, in which respects the New York telephone system is unapproached by that of any city in the world, there are ample and solid reasons why telephone service should be furnished much more cheaply in Europe than here. It is

(*Continued on page 105.*)

Special Electric Light Convention Supplement

ELECTRICAL REVIEW

NEW YORK, FEBRUARY 27, 1895.

"THE STORAGE OF ENERGY ESSENTIAL TO ECONOMY OF WORKING IN CENTRAL STATIONS."

BY N. W. PERRY, E. M., NEW YORK. READ BEFORE THE NATIONAL ELECTRIC LIGHT ASSOCIATION, CLEVELAND, FEBRUARY, 1895.

The Committee on Data reporting at the Washington meeting stated that 1.5 pounds of coal per indicated horse-power with a combined engine and dynamo efficiency of eighty-one per cent would produce 402.84 watt hours per pound of coal. In the tabulated statement of data collected by this same committee, the highest results of practice given were 208 watt hours per pound of coal. The next highest was 192, the lowest, twenty-five, and the average 91.7 watt hours, or only 22.7 per cent of that which the best practice under favorable conditions should give.

By far the larger number of stations reporting are small ones, in which the highest economies would not be expected, and we find, as a matter of fact, that most of these report results below the average. Discarding all results based on a consumption of less than 10,000 pounds of coal, we have an average for the largest stations of 127.7 watt hours per pound of coal. This is equivalent to a consumption of about five pounds of coal per indicated horse-power. The best results given (208) are equivalent to about three pounds per indicated horse-power, or more than twice as much as the machinery involved requires for the best results. Bad as this showing is, it seems to compare favorably with foreign practice, for Professor Unwin says:* "Probably up to the present (1893), the consumption has in no case been less than 3.3 pounds per indicated horse-power."

When we consider how enormously short the results of actual practice in lighting stations are of those which are obtainable under the most favorable conditions with the same machinery, it behooves us to inquire into the cause of this deficiency and to see how far we can remedy it.

Professor Kennedy has made some very careful tests to indicate the effect of variable load upon coal consumption. Dividing the day into three portions, he determined the fuel consumption, the feed water evaporated and the indicated and electric horse-power developed during each period in an English lighting station. It will be seen that during the periods of light load the fuel consumption per horse-power is very large.

COAL CONSUMPTION IN BOILERS WITH VARIABLE LOAD.

	11 A. M. to 6 P. M. 7 hours.	6 P. M. to Mid-night. 6 hours.	Midnight to 11 A. M. 11 hours.	Mean for 24 hours.
Total indicated horse-power hours	562	1,366	407	....
Total electric horse-power hours	400	979	260	....
Coal per indicated horse-power hours pounds.	6.88	3.26	6.26	4.65
Coal per electric horse-power hours pounds.	9.67	4.55	9.80	6.62
Pounds water evaporated per pound coal	5.92	9.60	9.27	8.21
Pounds water per indicated horse-power hour.	40.7	31.3	57.7	38.3
Pounds water per electric horse-power hour.	57.2	43.8	91.0	54.4

Comparing the consumption of steam and coal during mean load with that during the hours of heavy load (6 P. M. to midnight) we find that the mean steam consumption per electric horse-power hour was twenty-four per cent greater and the mean coal consumption per electric horse-power hour was forty-six per cent greater—the difference of twenty-two per cent being attributable to waste at boilers, due to irregular working. During the whole twenty-four hours the mean evaporation in pounds of water per pound of coal was only eighty-five per cent of the evaporation during the period of maximum load.

Captain Sankey has applied Mr. Willans' formula to find the steam consumption of one or more engines working against a variable load in an electric lighting station. He takes a normal midwinter load curve and examines how the necessary current could be supplied during the twenty-four hours (1) with an engine capable of exerting the maximum power required; (2) with smaller engines. The results, rearranged and a little modified, are given by Unwin in the following table. It is assumed for convenience that the maximum load is 500 electric horse-power and that the engines are non-condensing.

STEAM CONSUMPTION IN ENGINES WORKING WITH A VARIABLE LOAD.

	Average load factor.	Steam consumption in pounds per average electrical horse-power hour.	Per cent increase of steam consumption due to variable load.
I. 500 electric horse-power engine	0.22	50	108
II. 200 electric horse-power engines	0.49	34.5	44
III. 100 electric horse-power engines	.65	29.5	23

* On the Development and Transmission of Power, page 28.

We thus see how closely these results agree with Professor Kennedy's figures, derived from direct tests which gave twenty-four per cent increased consumption at mean load over that at maximum load.

The efficiencies of engines and dynamos in lighting stations are maintained quite high, notwithstanding the variable output of the establishment, by throwing in and out units as the load varies, so that at most only one unit need be working at less than its best load and the variation in efficiency of this one unit is chiefly due to the larger proportion of the whole that the friction losses bear at light load. Almost the whole loss of efficiency, *due* to variable load, is, therefore, attributable to the boiler.

There is still another class of losses which is not amenable to calculation, viz., those due to leaks from boiler fittings and steam pipes, with condensation losses in the steam pipes, and due to the wasteful use of steam by all present known means of boiler feed. As these losses continue practically constant throughout the twenty-four hours they assume especial importance where the load factor is low.

To show more clearly at what relative cost we produce power in our lighting stations with their variable loads and under other commercial conditions where the lead is fairly constant, I quote Professor Unwin:

I. *Engines working on a very regular load, in conditions similar to those of an engine pumping to a reservoir.* Here for one effective horse-power exerted during 7,884 hours annually, engines of 1.47 indicated horse power must be provided. Such engines may be taken to use fourteen pounds of steam per indicated horse-power hour in test trials, but in ordinary work seven and one-half per cent more must be allowed for leakage, working auxiliary engines and less careful attention, this makes the consumption fifteen pounds per indicated horse-power, or $15 \times 1{,}176\ (.^1_{15}) =$ eighteen pounds per effective horse-power hour. At nine pounds of steam per pound of coal, allowing also five per cent for lighting and banking fires, the engine would use 2.1 pounds of coal per effective horse-power hour.

COST OF INSTALLATION PER EFFECTIVE HORSE-POWER.

Cost of engines or with reserve 1.47 indicated horse-power = 1.47 × $44.5	$65.42	
Cost of boilers = 1.47 × $24	35.28	
Cost of buildings = 1.47 × $30	44.10	
Total	$144.80	

ANNUAL COST OF WORKING PER EFFECTIVE HORSE-POWER.

Interest on $144.80 at 4 per cent	$5.79	
Maintenance and depreciation—buildings at 2 per cent	.88	
Machinery at 7½ per cent	7.61	
Total fixed annual cost		$14.28
Coal 2.1 pounds for 8,760 hours at $1.75 per ton	$16.10	
Petty stores	1.64	
Driving, stoking and cleaning	11.67	
		29.41
Total annual cost		$43.69

STEADY WORKING COST OF ONE ELECTRICAL HORSE-POWER.

Cost of engines, 1.547 at $44 5	$68.84	
Cost of boilers, 1.547 at $24	37.13	
Cost of dynamo, 1 at $30	30.00	
Cost of buildings, 1.547 at $30	46.41	
	$182.38	
Interest on $182.38 at 4 per cent	7.30	
Maintenance and depreciation—buildings at 2 per cent	.93	
Machinery at 7½ per cent	10.20	
Total fixed annual cost		18.43
Cost of coal, 2.21 pounds, 8,760 hours, at $1.75 per ton	$16.94	
Cost of petty stores	1.64	
Cost of driving, stoking and cleaning	11.67	
		30.25
Total annual cost per electric horse-power		$48.68

II. *Engines working with variable load under conditions similar to those of an electric lighting station.* Here for one effective horse-power supplied on the average throughout the year engines of 5.87 indicated horse-power have to be provided. On account of the inefficiency and waste, due to variation of the load, it is best to estimate the steam and coal from experience in similar cases. Probably no electric lighting station at present works with quite so low a consumption as six pounds of coal per hour per electrical unit supplied. A consumption of nine pounds is probably much more common in the best managed stations. Six pounds of coal per electrical unit corresponds to 3.8 pounds per effective horse-power hour.

COST OF INSTALLATION.

Cost of engines for one average effective horse power with reserve, 5.87 indicated horse-power = 5.87 × $44.5	$261.22	
Cost of boilers = 5.87 × $24	140.88	
Cost of buildings = 5.87 × $30	176.10	
Total	$578.20	

ANNUAL COST OF WORKING PER EFFECTIVE HORSE-POWER.

Interest on $578.20 at 4 per cent	$23.13	
Maintenance and depreciation machinery at 7½ per cent	30.25	
Buildings at 2 per cent	3.50	
Total fixed annual cost		$56.88

Total fixed annual cost brought forward.		**$56.88**
Cost of coal, 3.8 pounds for 8,760 hours, at $1.75 per ton	$26.00	
Cost of petty stores	1.64	
Cost of driving, stoking and cleaning	11.67	
		39.31
Total annual cost		$96.19

In other words our power costs us 2,138 times as much in an electric light station as it should. If we figure out the relative costs per electrical horse-power, the disparity will be still greater.

Using these same data, but carrying the results out to electrical horse-power, assuming a dynamo efficiency of ninety-five per cent., we have four pounds of coal per electrical horse-power.

COST OF INSTALLATION PER ELECTRICAL HORSE-POWER.

Cost of engines, 6.17 × $44.5	$274.56	
Cost of boilers, 6.17 × $24	148.08	
Cost of buildings, 6.17 × $30	185.10	
Cost of dynamos, 4, at $30	120.00	
Total	$727.74	
Interest on $727.74 at 4 per cent	29.11	
Maintenance and depreciation machinery, $542.64, at 7½ per cent	40.70	
Buildings, $185.10, at 2 per cent	3.70	
Total fixed annual cost		$73.51
Cost of coal, 4 pounds for 8,760 hours, at $1.75 per ton	$30.63	
Cost of petty stores	1.64	
Cost of driving, stoking and cleaning	12.00	
		44.27
Total annual cost electric horse-power		$117.78

When we compare this with the cost resulting from steady working, viz., $48.68, we see what an effective method of storage means in our central stations. If our storage costs us nothing, it would result in a saving for each electrical horse-power generated per year of $117.78 — $48.68 = $69.10. But any system of storage which we may employ will involve expenditures, both in the way of losses in storage, which will have to be provided against by an increased plant to provide for the same ultimate output, and in the way of interest on the additional investment required by the storage plant. As a matter of fact, these additional costs must in all cases be less than the saving otherwise effected, else we are paying more for our economy than it amounts to. In the present case, our storage must cost us less than $69.10.

If we could take the variable load off between the boiler and engine, viz., devise some means by which the same amount of energy could be supplied by the continuous operation of a boiler plant working at its most economical rate, we would at once do away with one of the most serious losses due to irregular working. Let us see how much the saving would be if the irregular working of the boilers could be obviated without cost.

Cost of engines, 6.17 at $44.5	$274.56	
Cost of boilers, 1.547 at $24	37.13	
Cost of buildings, 4, at $30	120.00	
Cost of dynamos, 4, at $30	120.00	
Total	$551.69	
Interest on $551.69 at 4 per cent	22.07	
Maintenance and depreciation machinery, $431.69, at 7½ per cent	32.38	
Buildings, $120, at 2 per cent	2.40	
Total fixed annual cost		$56.85
Cost of coal, 2.21 pounds for 8,760 hours, at $1.75 per ton	$16.93	
Cost of petty stores	1.64	
Cost of driving, stoking and cleaning	11.67	
		30.24
Total annual cost per electrical horse-power		$87.09

If the storage cost us nothing, and was applied between the boiler and the engine, it would affect a saving of $117.78 — $87.09 = $30.69. The limiting expense, therefore, to which we can go for storage at this point is $30.69 per annual electrical horse-power.

If we move our storage forward one step and introduce it between our engine and dynamo, so that everything previous to the dynamo would work continuously at its maximum economy, the account would stand thus:

STORAGE BETWEEN ENGINE AND DYNAMO. COST OF ONE ELECTRICAL HORSE-POWER.

Cost of engines, 1.547 at $44.5	$68.84	
Cost of boilers, 1.547 at $24	37.13	
Cost of dynamos, 4, at $30	120.00	
Cost of buildings, 4, at $30	120.00	
Total	$346.97	
Interest on $346.97 at 4 per cent	$13.86	
Maintenance and depreciation machinery, $226.97, at 7½ per cent	17.02	
Buildings, $120, at 2 per cent	2.40	
Total fixed annual cost		$33.28
Cost of coal, 2.21 pounds, 8,760 hours, at $1.75 per ton	$16.94	
Cost of petty stores	1.64	
Cost of driving, stoking and cleaning	11.67	
		30.25
Total annual cost per electrical horse-power		$63.53

The saving by introducing storage at this stage would be $117.78 — $63.53 = $54.25, or a gain by moving the storage forward one step of $54.25 — $30.89 = $23.56. If we move it forward still another step, and bring it between the dynamo and distribution, we have an additional possible gain of $69.10 — $54.25 = $14.85.

Recapitulating, we have possible gains by introducing the storage by successive steps forward.

		Cost of Horse-power at this stage.
Between boiler and engine	$30.69	$48.68
Between engine and dynamo	23.56	87.09
Between dynamo and distribution	14.85	117.78
Total	$69.10	

BATTERY STORAGE.

Supposing, in the case assumed, we endeavor to equalize the load by means of the storage battery. This will allow the boilers, engines and dynamos to work continuously at their most economical rate and would seem to provide ideal conditions of working. We are not, however, storing the product we have to sell as is the gas manufacturer—we are not storing electrical energy, as some suppose, but, chemical energy, which must be transformed again into electrical energy before we can distribute it. These two transformations, of course, involve a loss of energy which must be provided for in boilers, engines and dynamos and also in coal. To be entirely fair with the storage battery, let us assume that its efficiency under all conditions is seventy-five per cent. Then in order that we may have at average working one electrical horse-power, we must provide:

Boilers, $\frac{1.547}{.75} = 2.07$ at $24	$49.68
Engines, $\frac{1.547}{.75} = 2.07$ at $44.5	92.12
Dynamos, $\frac{1}{.75} = 1.333$ at $30	40.00
Buildings, say	125.00
Total investment, without storage battery	$306.80

If we are to produce an average of one electrical horse-power per hour, we will produce twenty-four horse-power hours during the twenty-four hours, half of which must be stored, viz., we must have storage battery capacity for twelve horse-power hours. Of course, the rate of discharge will have some bearing upon the cost of this storage battery capacity, but taking an abstract case, we may assume, I think, without being unfair, that it will cost $35 per electrical horse-power hour capacity erected. We must, therefore, add to our former figures, 12 × $35 = $420, which is more for the batteries than we have allowed for all the rest of the plant put together, including the buildings.

The total fixed investment therefore becomes	$726.80	
Interest on $726.80 at 4 per cent	29.07	
Maintenance and depreciation		
Buildings, $125 at 2 per cent	2.50	
Machinery, $181.80 at 7½ per cent	13.64	
Storage Battery, 420 at 10 per cent	42.00	
Total fixed annual cost		$87.21
Coal, 2.95 pounds for 8,760 hours, at $1.75 per ton	$22 61	
Petty stores, attendance, etc	13.37	35.92
Total annual cost per electrical horse-power		$123.13

which would be an actual loss over that of irregular working of $123.13 — $117.78 = $5.35. It will cost with the storage battery thus used, $123.13 — $48.68 = $74.45 more than the same machinery working continuously on a steady load could produce it for.

If we assume coal to cost $3.50, instead of $1.75, the cost per electrical horse-power will be:

Steady load without storage battery	$ 52.31
Variable load without storage battery	148.40
With storage battery	145.74

This does not condemn its use in central stations in other ways, however, for there are many cases in which its use may contribute to economy, but these cases cannot be determined by any general rational formula. Each case must be determined for itself, and the result will depend primarily, upon the shape of the load line, and secondarily, upon the ability of the battery to rise above normal discharge rate economically. In the case of a station previously equipped, without storage, so that the units are already determined, the question of economy of introducing storage batteries will be determined in some cases entirely by the sizes of those units.

In some cases where the day load is exceedingly light, it will not warrant the operation of the plant at all—the load costs more than it will bring in. In such cases there can be no question as to the economy of the storage battery, since it can be charged during the night by power that would otherwise be practically wasted, and during the daylight hours it may carry the whole load. In such cases it will effect an economy in another way also, viz., by carrying up to its capacity the peak of the load. The economy in this direction will be the greater the sharper the peak and will disappear as this flattens out.

But the manner in which the storage battery is most frequently employed to advantage in a central station is by changing the load line from the irregular one, due to the natural load, to one which would be formed by a series of rectangles which would in the aggregate have about the same area.

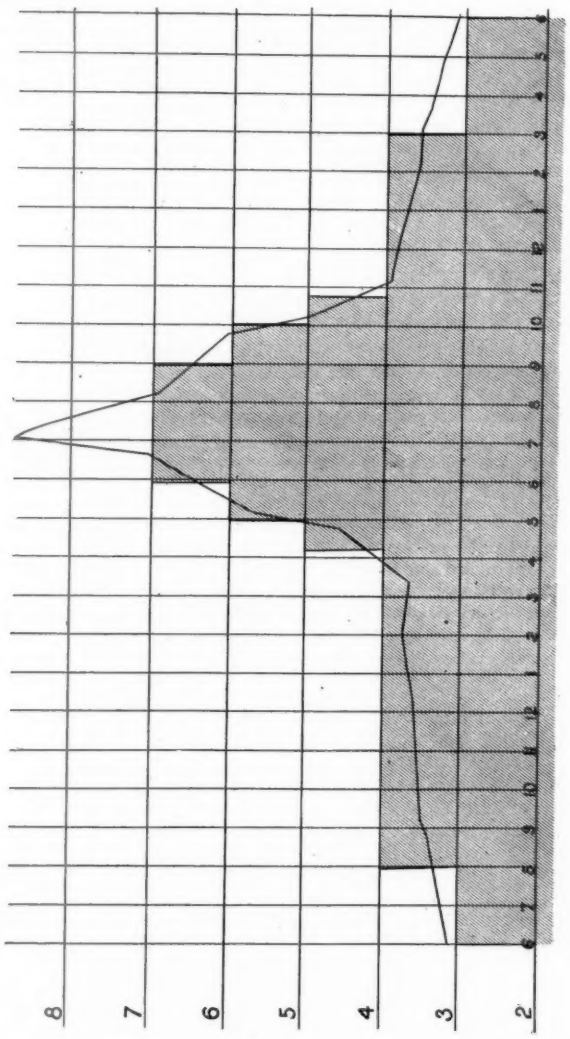
I have endeavored to illustrate this in the accompanying diagram. The irregular black line represents the natural load line. The spaces between the horizontal lines represent the units into which the equipment is divided, and the vertical lines the time at intervals of two hours.

Beginning at 6 A. M. the load is a little above the best output for three units, but without too much overloading these three units can carry it. The line gradually rises, however, until at 8 A. M. it becomes too much of an overload for three units. If a fourth unit were thrown in it would at first have to operate at only about one-third load, and hence very uneconomically. A storage battery load sufficient to make up a full load for this unit would, therefore, be thrown in at 8 A. M., and the new unit would thus work economically from the start. The part of the load furnished by the battery is represented by the shaded portion outside the natural load line—that is to say, this much energy is being absorbed by the battery and will be available at another time—less the loss due to inefficiency of the battery. I have assumed a battery efficiency of seventy-five per cent. We see from the diagram that the battery is charging 8 A. M. to about 4 P. M. Twenty-five per cent of the energy *thus* stored will therefore be lost. It will be apparent that this bears no relation whatever to the total amount of energy being generated at the time, for units 1, 2 and 3 are working directly into the feeders and are not affected at all. The energy thus lost bears an exceedingly small ratio to the total energy generated.

At 4 P. M. the natural load consumes all the energy of the third unit, and

in about twenty minutes has increased so as to be an overload. Now it depends upon circumstances whether we will bring our stored energy to the assistance of the fourth unit to carry the increasing load further or not. For the purpose of illustration I have assumed that we will not, but will throw in our fifth unit and complete its load by charging the battery. At ten minutes to five the load line crosses the fifth unit line, rising very rapidly, and the same question arises again, but I throw in my sixth unit at once, completing its load; the shaded area outside the natural load line again being the energy taken by the battery, seventy-five per cent of which will be available. At 5.30 the load exceeds the normal capacity of all six units, but the diagram represents them as carrying the increasing load until 6 P. M., when the seventh unit is thrown in, and the load completed by the storage battery until 6.40, when the natural load requires the whole attention of all seven units.

Now the question arises, will it be necessary to add first an eighth and then a ninth unit to take this peak? If so, it will add considerably to the fixed charges on our power account. Will it be cheaper to supply battery



ADJUSTING BATTERY STORAGE TO ELECTRIC LIGHT LOAD LINE.

capacity to carry this peak? That is a question to be decided separately for each individual case. Storage batteries will stand an abnormal discharge for a short time without serious injury. Some will stand it better than others. If it be too rapid the depreciation charge will be increased, also if this abnormal discharge be continued too long. Then, too, at rapid discharge the battery becomes less efficient and the loss will become greater than twenty-five per cent. It is only by balancing these losses against the advantages that the question can be decided whether it will be more advantageous to throw in an eighth unit and let the battery take care of only the tip of the peak beyond that, or let the battery take the whole of the peak beyond the seventh unit line. In the diagram I have assumed that the latter is more advantageous. The battery, therefore, discharges until 8.20, when it begins to recharge, supplementing the seventh unit load until 9 P. M., when the seventh unit is thrown out entirely, and the battery carries the remaining seventh unit load until 9.25, the battery load being represented by the unshaded triangle within the load line. And so the battery and units continue supplementing each other throughout the remaining hours.

In this way the battery will prove economical with some curves. In others it may not, but whether or not it will depends upon so many contingencies that it is utterly impossible to state *á priori*. There are other considerations than economy that might balance its absence, such as convenience as a regulator of potential; the facility it affords for distribution to sub-stations at high potential, resulting in an economy of copper; and the subsequent transformation down for local distribution; and some others which will suggest themselves. Some of these might be controlling in special cases.

Then, on the other hand, the employment of the storage battery is limited entirely to the storage of energy when generated in the form of electricity; not only this, but it is still further limited to direct currents, and is therefore of no avail in stations sending out alternating currents.

GAS STORAGE AND GAS ENGINES.

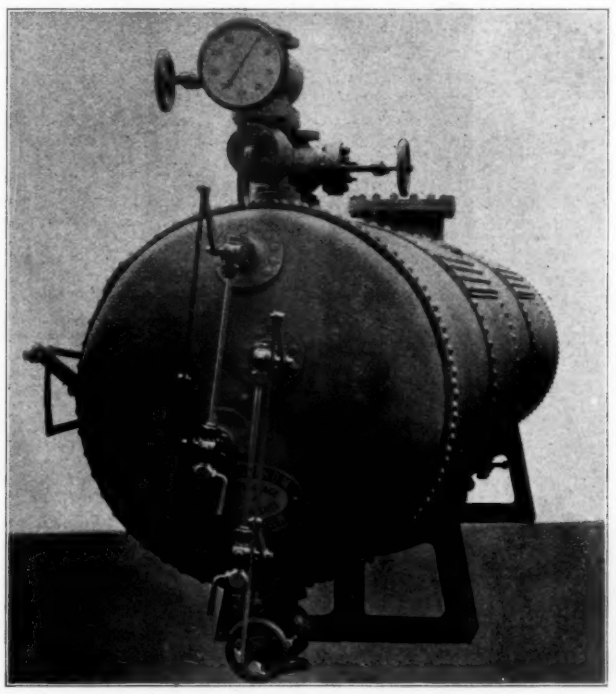
For strictly power purposes the use of gas engines is now, more than ever before, attracting attention, and abroad the gas engine has already found its way into the central station and it has made its bow here also.

On purely theoretical grounds at least the gas engine deserves our consideration at this point for the following reasons: In the first place, we may replace the wasteful standby losses of steam boilers under the variable central station load by the ideally simple and economical system of gas storage. The use of the gas engine, therefore, comes legitimately within the province of this paper, since it permits of employing a substitute for the boilers, which may be operated continuously at the most economical load, and yet supply with equal efficiency the most variable load that can possibly be thrown upon it

Comparing the relative theoretical advantages of the gas engine and the steam engine, Professor Kennedy states that the maximum theoretical efficiency of the steam engine is thirty per cent. Its obtained efficiency is about ten per cent. The theoretical maximum efficiency of the gas engine is eighty per cent. Its efficiency obtained in practice is twenty-five per cent. These facts have led Mr. Thwaite to say that the practical efficiency of the gas engine is equal to the theoretical efficiency of the steam engine. As a matter of general experience, however, under usual working conditions with large engines, very little if any advantage in efficiency is shown by the gas engine over that driven by steam, but if this statement is disputed, as I am not at all sure that it cannot be successfully, the burden of proof lies with the gas engine. At any rate for our purposes it will be proper to assume that the two are on a par as regards ultimate efficiency, and that so far as this is concerned the two types of engines may be interchanged in any installation which we may consider without affecting the result.

The gas engine has this practical advantage that it may be started and stopped when required, thereby avoiding the standby losses so fatal to economy where boilers are used. These standby losses for boilers are given by Dowson* as ten per cent; that is to say, that boilers that are standing idle and furnishing no steam will require ten per cent of the fuel they will take when working at their rated capacity. The gas plant, however, where gas storage is employed, has no standby losses of this kind, but, in many cases where fuel gas is manufactured to be used on the premises adequate storage is not provided and in times of light load part of the plant is banked. Under these conditions, Dowson states that the standby losses will not exceed 2.8 per cent. The advantages in favor of the gas engine in this respect, even under the most unfavorable circumstances are therefore as 10 to 2.8 or 3.

As to fuel consumption in gas engines, foreign practice furnishes considerable data. Messrs. Crossly guarantee one brake horse-power hour on a consumption of one pound of anthracite coal, using Dowson gas. Under test conditions† the gas engine plant at Chateau Say, supplying 650 lamps, consumed 1.2 pounds per indicated horse-power hour. At Leven Tweed Mills, four gas engines, aggregating 200 horse-power, used in six days' trial one and one-quarter pounds anthracite per brake horse-power hour, or one and three-quarters pounds gas coke per brake horse-power hour. At the Godalming mills gas engines, aggregating 400 indicated horse-power, averaged one pound of fuel (character not stated) per indicated horse-power. At the Chelsea flour mill a sixty nominal horse-power, twin cylinder gas engine with Dowson gas, under full load test, used 0.87 pounds coal per indicated horse-power. But as we are all aware the fuel consumption under test con-



PERRY'S PAPER.—HALPIN'S THERMAL STORAGE TANK.

ditions is no criterion to judge by, and especially misleading when we have under consideration an electric lighting plant. Furthermore, as I think has been conclusively shown, the fuel is by no means the only expense attending the production of power. Mr. Dowson places the cost of a Dowson gas plant of eighty horse-power at $20.31 per horse-power, and for a plant large enough to supply 530 horse-power, at $10.37 cents per horse-power. The wages of firemen for a gas plant are no more than for a steam plant, and a much

* "Gas Power," a paper by Emerson Dowson in the *Engineering Review*, November 30 and December 20, 1894.

† Bryan Donkin, before Incorporated Institute of Gas Engineers.

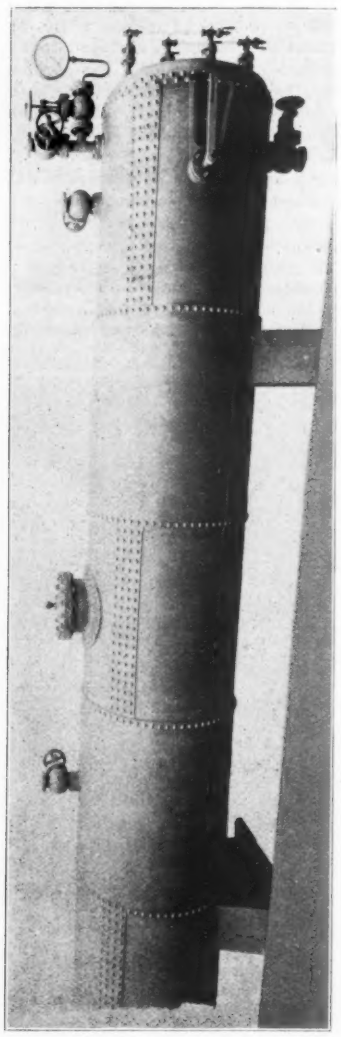
cheaper fuel may be used. But let us assume that the fuel in both cases costs the same per ton, that the gas plant costs $20 instead of $10, so as to cover the cost of extra land required. Then our account would stand something like this:

Cost of engines, 6.17 at $50	$308.50	
Cost of gas plant, 1.547 at $20	30.94	
Cost of buildings	120.00	
Cost of dynamos	120.00	
Total fixed investment	$579.44	
Interest on $579.44 at 4 per cent	$23.18	
Maintenance and depreciation of machinery, $459.44	34.06	
Buildings, $120 at 2 per cent	2 40	
Total fixed annual cost		$59.64
Cost of coal, 2 pounds, 8,760 hours, at $1.75	$15.33	
Cost of petty stores	1.64	
Cost of driving, stoking and cleaning	11.67	
		28.64
Total annual cost per electric horse-power		$88.28
With coal at $3.50 the total cost		$103.61

Saving over present methods, with coal at $1.75 = $117.78 — $88.28 = $29.50; with coal at $3.50 = $148.40 — $103.61 = $44.79.

THERMAL STORAGE.

Mr. Druitt Halpin, of England, has devised a method of thermal storage which has attracted wide attention abroad and is likely to attract great attention in this country as soon as its efficiency becomes better understood. We all know that a boiler when supplying an intermittent demand is capable of supplying for a short time energy at a much more rapid rate than its steaming capacity would warrant; that during the period of light load it has stored up a certain amount of energy which it can give out again when called upon to do so. It will have been observed that during the period of comparative rest the pressure in the boiler will have increased as also the temperature of the water and steam. It is this increase of temperature that constitutes the storage of energy and with the same increase of temperature above the normal working temperature, the amount of energy stored will be



HALPIN'S THERMAL STORAGE TANK.

proportional to the quantity of water heated. Since the quantity of water usually employed in our boilers is comparatively small the storage of energy in them within the limits of safe pressure is, therefore, limited. Mr. Halpin, however, has conceived the plan of connecting the boilers to large iron storage tanks filled with water which is brought to the same temperature and pressure as the boiler. It is a condition of any system of heat storage for central stations that the energy stored should be recoverable whenever and at any rate of supply required. Superheated water fulfills this condition, for if the pressure is reduced steam is generated instantly and in controllable amount. This has given rise to three methods of procedure, which he has designated respectively "steam storage," "feed storage" and "combined feed and steam storage."

The first of these was very fully described by Prof. George Forbes at the St. Louis convention. The other two are later developments.

In the steam storage system Mr. Halpin employs only sufficient boilers to supply the mean demand and storage tanks sufficient to supply the maximum demand. These latter not being subjected to the fire will suffer but little deterioration, and being simple iron reservoirs of sufficient strength to withstand the pressures required are comparatively inexpensive to install. The boilers working continuously at their most economical rate have their excess of energy during light load stored up in the water of the tank, from

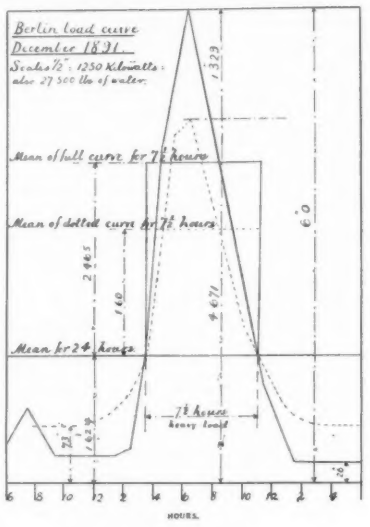


FIG. 1.

which it may be drawn at will during heavy load. He proposes that the boilers and tanks shall work under a pressure of 265 pounds per square inch when fully charged, which corresponds to a temperature of 406 degrees Fahrenheit. He proposes that the engines be worked at 130 pounds per square inch, which corresponds to 347 degrees Fahrenheit. The total available heat stored when the reservoirs are fully charged is the difference of the total heat of the water at 406 degrees and at 347 degrees Fahrenheit, or that due to a range of temperature of fifty-nine degrees. Every pound of water falling in temperature through that range will yield sixty-one thermal units of heat. The total heat required to generate a pound of steam at 130 pounds per square inch from water at 347 degrees is 868.8 thermal units. Consequently fourteen and one-quarter pounds of water falling in temperature from 407 degrees to 347 degrees will yield one pound of steam. To allow for radiation loss and imperfect working, this may be taken at sixteen pounds of water per pound of steam. The steam consumption per effective horse-power may be taken at eighteen pounds per hour in condensing and twenty-five pounds per hour in non-condensing engines. The storage room per effective horse-power by this method would, therefore, be $\frac{16 \times 18}{62.5} = 4.06$ cubic feet for condensing and $\frac{16 \times 25}{62.5} = 6.4$ cubic feet for non-condensing engines.

Gas storage, assuming that illuminating gas is used, would require about twenty cubic feet of storage room per effective horse-power hour stored, and if ordinary fuel gas were stored it would require about four times this capacity.

In water storage 317 cubic feet would be required at an elevation of 100 feet to store one horse-power hour, so that we see that of the three methods of storing energy the thermal method is by far the most economical of space.

In the steam storage method the boiler is completely filled with water and the storage tank nearly so. The two are in free communication by means of pipes, and a constant circulation of water is maintained between the two, but the steam for the engines is taken only from the top of the storage tank through a reducing valve.

In the feed storage system, the excess of energy during light load is stored in the tanks as before, but the boilers are not completely filled. In this system the steam is taken exclusively from the boilers, the superheated water of the storage tanks being used during heavy load as feed water to the boilers.

The third method, as the name would imply, is a combination of these two. In the "combined" feed and steam storage system the pressure in boiler and storage tank is equalized by connecting the steam spaces in both by pipe, and the steam for the engines is, therefore, taken from both. In other words, they work in parallel.

An incidental advantage of thermal storage is the purity of the water supplied to the boilers. Since the latter derive their feed water from the hot reservoirs, it will have deposited its impurities where they can do no harm. The only unavoidable losses that need be considered in connection with thermal storage are those due to radiation from the reservoirs. This can be provided against by proper lagging so as to be insignificant, and be still further reduced if there be a number of reservoirs. If, for instance, there are four, each will radiate from three-quarters of its surface towards the other three, and only from one-quarter of its surface into space.

STEAM STORAGE SYSTEM.

As illustrating the *modus operandi* and cost of the system of "steam storage," as it is called, I quote from a report by Mr. Wm. Schonheyder, who, taking the load line of the Berlin electric lighting station as a basis, has figured out the relative costs of operation with and without a steam storage system. Fig. 1 is the load line of this station for December, 1891. The scale of the diagram is 1,250 kilowatts per ½ inch, and the water consumption is taken at twenty-two pounds per kilowatt hour. Using storage tanks eight feet in diameter, this would give a scale for water consumption of one inch to 27,500 pounds per hour. The maximum load is 7,500 kilowatts, requiring, say, 10,000 electrical horse-power. The minimum load, according to the curve, is 320 kilowatts, and the proportion of the maximum to minimum work

required from the boilers will be as 7,500 to 320 or as 23.4 to 1. The mean load was 2,030. Excess of maximum above mean, 5,080, or a load factor of about twenty-seven per cent. Duration of maximum above mean, 7.5 hours.

In estimating for the steam storage system, the extra quantity of steam wanted during seven and one-half hours, and which has to be produced from the water in the tanks, is represented by the area inside the full line curve, Fig. 1, and the straight mean line for twenty-four hours. The boilers and tanks will, under this system, have to work at 250 pounds gauge pressure, equal to 265 pounds absolute for a large portion of the twenty-four hours. This extra steam, then, is $2.465 \times 27{,}500$ pounds $\times 7\frac{1}{2}$ hours $= 508{,}200$ pounds at 130 pounds absolute pressure as required by the engines, and this is equal to an expenditure of 508,200 pounds $\times (1219° - 376°) = 428{,}413{,}000$ heat units—376° being the mean temperature of the water from which the steam is produced, viz., 406° at beginning of heavy load and 347° at the finish; 1219° is the total heat of 130 pounds steam. Since the water in the tanks, in producing this steam, cools from 406° to 347° it gives up, say, 59 heat units per pound, and we shall therefore require $\frac{428{,}413{,}000}{59} = 7{,}261{,}000$ pounds water in the tanks. Taking the tanks, as before, as holding an available (steam room required at top) 750,000 pounds each, we want $\frac{7{,}261{,}000}{75000} = 97$ tanks.

The necessary boiler power, compared to that of the present installation, will be in proportion of 1.624 to 6, and allowing, say, five per cent extra cost for the increase in pressure, we get the cost of boiler plant with steam storage tanks equal to

Boilers,	$\frac{1.624}{6}$	× £30,000 × 1.05	=	£8,526
Tanks,	97 ×	£500 × 1.05	=	50,925
		Total,		£59,451

This is nearly double the cost of the existing plant, but as we will see later, the saving in fuel and in other ways makes the increased investment pay when fuel is dear.

THE FEED STORAGE SYSTEM.

According to this system, approximately the whole of the feed water required for the twenty-four hours is pumped into the feed tanks during the time of light loads; so much of it as the boilers require during this time is supplied from the tanks, and the rest (which will be that wanted during the heavy load time) is retained in the tanks and heated up by the surplus steam during the said light load time up to or nearly to the temperature of the steam in the boiler, viz., 347°, and is used as boiler feed during the heavy load.

By this method of working the duty required from the boilers will be considerably lessened, for, while during the time of maximum load they will still be required to supply steam at the rate of six inches $\times$ 27,500 = 165,000 pounds per hour, the total heat which they have to gather from the fuel and impart to the water will be lessened by the increase in temperature of feed from 100° to 347°, a gain of 247°. The total heat of 130 pounds absolute steam being 1,219°, we have the maximum heat to be supplied by the boilers at present $= 165{,}000 \times (1{,}219° - 100°) = 165{,}000 \times 1{,}119 = 184{,}635{,}000$ units of heat hourly. Whereas with the feed storage the maximum required $= 165{,}000 \times (1{,}219° - 347°) =$ only 143,800,000 units. In other words, $\frac{1}{4.53}$ of the maximum work of the boilers is avoided and a corresponding number can therefore be laid off.

During every stage of the heavy load, with 347 degrees feed, the same proportion of boiler work is saved, and this is illustrated on the diagram by the dotted curve and figures, 4.67 inches representing the maximum required work with feed storage, against six inches without, equal to a gain of 1.329, which is $\frac{1}{4.53}$ of 6.11, or twenty-two per cent.

The dotted curve of required boiler duty, during the seven and a half hours under the new conditions, is, therefore, quite definite as to form and also as to area enclosed by it. The dotted curve during the remaining sixteen and a half hours of light load must be such that the deficiency in work during these hours equals the excess of work during the heavy load time, and the area it encloses is, therefore, quite definite, while its form depends upon the rates of working both as to firing and to feeding, and this form can with moderate care be made to assume that shown, which will give a maximum amount of work measuring 0.73 inch, so that the ratio of maximum to minimum becomes six to one, viz., $\frac{4.671}{.73}$, instead of the present 23.4 to 1; a reduction of irregularity of working which must necessarily be beneficial to the general working of the boilers and must effect a considerable saving of fuel.

The required tank capacity is easily estimated, being the total of water evaporated for seven a half hours, viz., $(1.624 + 2.465) \times 27{,}500$ pounds $\times 7\frac{1}{2}$ = 843,150 pounds. Taking the size of tanks proposed by Mr. Halpin of eight feet diameter by thirty feet in height and allowing for their not being emptied within some three feet of the bottom, so as to leave room for deposited mud, etc., they may each be taken as containing a working quantity of 75,000 pounds of water, so that full eleven of them would be wanted, viz., $\frac{843{,}150}{75{,}000} = 11.24$.

The cost of these, including fittings and coverings, I will take at £500, which I believe to be a liberal estimate, so that if we allow for a reduced number of boilers, according to the reduced maximum work required for them, we shall have the cost of boiler plant on this system:

Boilers,	$\frac{4.671}{6}$	× £30,000	=	£23,360
Tanks,	11.24 ×	£500	=	5,620
		Total,		£28,980

COMBINED FEED AND STEAM STORAGE.

The same authority gives the following estimate of cost of this as follows: The saving of boiler duty, due to the feed storage only, is the same as for the previously taken case of feed storage, and is represented by the area enclosed between the full and the dotted curves during the seven and one-half hours of heavy work, and the extra steam to be produced is represented by the area enclosed between the dotted curves during the seven and one-half hours and the straight mean lines for twenty-four hours. This extra steam will amount to $1.60 \times 27{,}500$ pounds $\times 7\frac{1}{2}$ hours $= 330{,}000$ pounds requiring $330{,}000 \times (1{,}219° - 376°) = 278{,}190{,}000$ heat units. The water in tanks giving us, as before, fifty-nine heat units per pound in cooling, we shall want $\frac{278190000}{59} = 4{,}715{,}100$ pounds of water, which will require sixty-three tanks. Add tanks for feed storage as before = 11 = total of 74.

The boilers will cost as for steam storage	£8,526
The tanks will cost 74 × £500 × 1.05	38,850
Total cost	£47,376

This is over twenty per cent less cost than for the steam storage alone. It is not more complicated, since the feed and the steam may be stored in the same tanks; and it has the additional advantage of supplying nearly clean water to the boilers, as has the simple feed storage system, and the work on the boilers is uniform for the 24 hours, which will necessarily produce a considerable economy of fuel.

Comparing now the above four modes of working the boiler plant of such an installation as the Berlin electric station and tabulating Mr. Schonheyder's results we have the following tabular view:

	Present System.	With Feed Storage.	With Steam Storage.	With Feed and Steam Storage.
Steam pressure	115 lbs.	115 lbs.	115 to 250 lbs.	115 to 250 lbs.
Feed temperature	100°	100° to 347°	100°	100° to 347°
Rate of working	23.4 to 1	6 to 1	Uniform.	Uniform.
Feed water	Dirty.	Clean.	Clean.	Clean.
Cost of boilers	£50,000	£23,360	£8,526	£8,526
Cost of tanks	.....	£5,620	£50,925	£38,850
Total cost	£30,000	£28,980	£59,451	£47,376

All of the above was embodied in an article of mine published in the *Western Electrician*, of January 5, 1895.

Let us see how the data here presented, when interpolated in the case we assumed in starting out, affect the results.

WITH FEED STORAGE.

Engines	$274.56	
Boilers	113.47	
Buildings	120.00	
Dynamos	120.00	
Tanks	29.32	
	$657.35	
Allowing 10 per cent for interest, depreciation and maintenance on the investment, exclusive of tanks—which is the same as before—and only 5 per cent on the tanks, we have $628.01 at 10 per cent	$62.89	
29.32 at 5 per cent	1.47	
Total fixed annual cost		$64.27
Coal	$20.00	
Other expenses as before	13.31	33.31
Total annual cost per electrical horse-power		$97.58

WITH STEAM STORAGE.

Engines	$274.56	
Boilers	37.13	
Tanks	236.70	
Buildings	120.00	
Dynamos	120.00	
	$994.39	
$757.69 at 10 per cent	$75.77	
$236.70 at 5 per cent	11.83	
Total fixed annual cost		$87.60
Coal, 2.21 pounds at $1.75	$16.93	
Other expenses	13.31	30.24
Total annuul cost per electrical horse-power		$117.84

COMBINED FEED AND STEAM STORAGE.

Engines	$274.56	
Boilers	37.13	
Tanks	180.37	
Buildings	120.00	
Dynamos	120.00	
	$732.06	
$551.63 at 10 per cent	$55.16	
$180.37 at 5 per cent	9.02	
Total fixed annual cost		$64.18
Coal, 2.21 pounds at $1.75	$16.93	
Other expenses	13.31	30.24
Total annual cost per electrical horse-power		$94.42

The above calculations show that with coal at $1.75 per ton and a load line such as that assumed, there will be an annual saving with the feed water storage of $20 20 per horse-power annually; by steam storage a loss of six cents and by combined feed and system storage an economy of $23.36.

If, on the other hand, we assume coal to cost double this, or $3.50, which would perhaps be nearer the average conditions obtaining in this country, our energy without storage would cost us $148.40 per annual electrical horse-power.

With feed storage, $117.58; saving $30.82. With steam storage, $134.77; saving $13.63. With combined, $111.35; saving $37.05.

Being aware that Mr. Halpin had already put into practice his system of thermal storage, immediately upon the receipt of the invitation from your president to address you upon the subject of storage of energy, I solicited from Mr. Halpin information in regard to the results obtained. The time allowed for a reply was exceedingly limited, but he was kind enough to send me a letter, together with the two photos and diagrams which are reproduced.

The half-tones are of small feed storage tanks used in a plant already

erected, represented in sketch No. 2. The two boilers shown in sketch are "Cornish," five feet by six inches diameter by twenty-six feet six inches long, and have flues two feet nine and one-half inches diameter and five feet six inches grates with heating surface of 500 square feet and a grate area of fifteen by thirty-five square feet. Best Welsh coal is used, containing about 15,000 Board of Trade Units, and the plant drives the laundry, the electric lighting, duplex pump for elevators, the whole of the radiators, provides steam for cooking in the kitchen, and supplies the hot water service of a large hotel.

The feed is delivered from the town's water supply into the tank under the feed water heater, and by means of duplex pumps it is passed through the feed water heater, where it is raised to a temperature of about 200 degrees Fahrenheit, and from there it is forced into the top of the thermal storage vessel, where the feed pipe delivers horizontally into the steam space, towards the back end of the vessel, or away from the firing end of boilers. The blow-out for the dirt deposited in the thermal storage vessel is also at the back end, and this blow-out is connected directly with the main blow-out in front of boilers.

The feed passes along the thermal storage vesse', and is led out near the firing end of boilers by a pipe standing about nine inches above the bottom of the vessel. From here it gravitates into the boilers, the quantity being regulated by these valves.

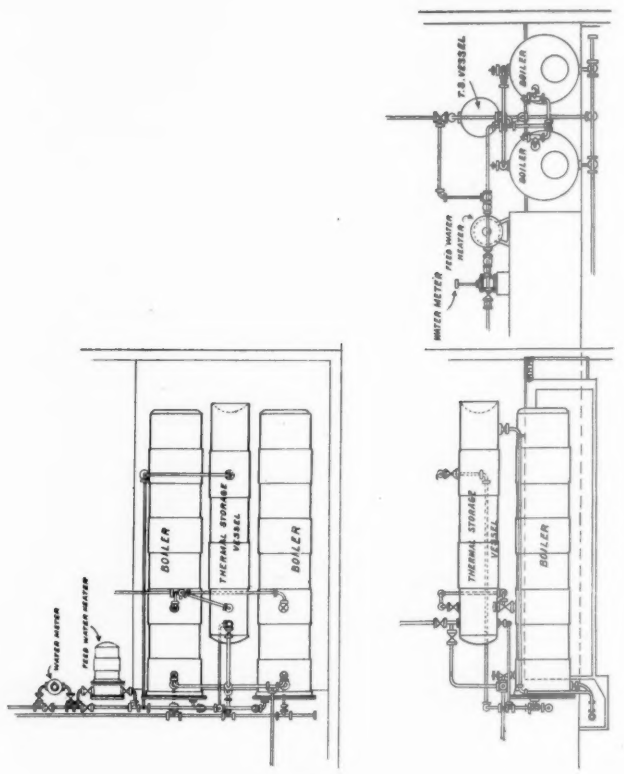


FIG 2.

ARRANGEMENT OF STEAM PLANT WORKING UNDER HALPIN'S FEED STORAGE SYSTEM, SUPPLYING STEAM FOR LIGHTING, HEATING, COOKING, ETC., IN LARGE ENGLISH HOTEL.

There is a pipe from the steam space of boiler direct into the top of the thermal storage vessel, so that there is always the same steam pressure between the boiler and thermal storage vessel, and the feeding into the boiler is effected by the head of water in the thermal storage vessel above the boiler.

He writes:

"I was obliged to start the plant before the makers had completed the thermal storage vessel, and its connections, and when the boiler working then was emptied, it was found to contain thirty-five buckets of sediment and incrustation.

After the feed storage was got to work, one boiler ran twenty-two days and nights continuously, and on opening out it was found absolutely devoid of scale or dirt.

I caused two tests to be made of eighteen hours each, during which the coal was accurately weighed and the water measured through a meter I had previously checked, with the following results:

When working without thermal storage, the evaporation reduced to 'from and at 212 degrees Fahrenheit' was equal to 10.95 pounds of water per pound of coal, and on the second test, when the thermal storage was at work, the evaporation was raised to 12.21 pounds.

Of course, you must bear in mind that this particular apparatus was only designed for feed storage, as *steam* storage was not required under the special conditions which had to be dealt with in this case.

Sketch No. 3 of the storage vessels, to work in connection with refuse destructors, shows four thermal storage vessels, the number required in this case.

You will, of course, observe that any possible effect of radiation, about which I am not at all frightened, are minimized, as the cylinders here radiate against each other, so that only one-quarter of the total surface, or, say, one cylinder, will be under the influence of losses from radiation.

I have arranged this plant so that there is a wooden gallery in the roof, and into this gallery *all* the various handles are brought for working the apparatus. I have taken this precaution so that should any joint break the men in charge are perfectly safe, and being in the gallery they can control the valves and blow the vessel off, any escaping steam passing out through louvres in the roof. The boilers for this plant are not shown.

You will observe the thermal storage vessels are completely finished in the riveting machine, not a single rivet being put in by hand, and owing to the form of the dished ends, there is not a single stay in the whole vessel, so that they are absolutely free to expand in any direction without doing injury by tearing themselves to pieces. All the valves, etc., are arranged so that any one, or all vessels, can be cut out of use."

In conclusion I will say that, of all the methods of storage available, the storage battery would, on theoretical grounds, be the best because of its forming the last link in the chain, thereby giving the economies of continuous working to all that precede. Unfortunately, it involves such large losses in itself as to nearly if not quite nullify the advantages it would otherwise present. And again, its extreme cost above all other methods renders it unavailable in any complete storage project, unless fuel is dear.

We are therefore compelled to go back of the engine for our equalization schemes and put up with the losses due to variable load upon all that follows. Fortunately the losses which we can overcome at this early stage are quite

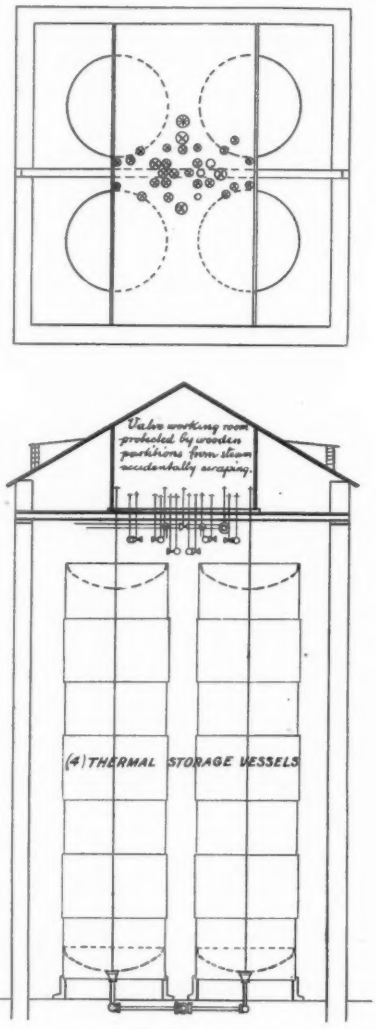


FIG. 3.

HALPIN'S COMBINED FEED AND STEAM STORAGE SYSTEM, IN CONNECTION WITH REFUSE DESTRUCTORS, TO SUPPLY STEAM TO A MUNICIPAL LIGHTING STATION. (BOILERS NOT SHOWN.)

considerable, and we have a number of methods at hand. Of these the gas engine—involving a gas storage—seems to give the best results. Very closely following this comes Halpin's combined feed and steam storage, followed by feed storage and steam storage. Below is given, in tabular form, the cost to produce for one year one electrical horse-power, with coal at $1.75 per ton and at $3.50 per ton; also, the saving effected by the various methods over present methods in a station having a mean load twenty-five per cent of its maximum.

	RECAPITULATION.		SAVING EFFECTED.	
	Coal $1.75 per Ton.	Coal, $3.50	Coal, $1.75	Coal, $3.50
Present method, steady load ...	$48.68	$65.62	.....	.....
" Gas Engine	88.28	103.61	$29.50	$44.79
Combined Feed and Steam Storage.....	94.42	111.35	23.36	37.05
Feed Storage.....	97.58	117.58	20.20	30.82
Without Storage, Load factor 25%	117.78	148.40	.....	.....
Steam Storage.....	117.84	134.77	— 00.06	+ 13.63
Complete Battery Storage	123.13	145.74	— 5.35	+ 2.66

"CORRECT METHOD OF PROTECTING ELECTRIC CIRCUITS."

BY W. E. HARRINGTON, PHILADELPHIA, PA. BEFORE THE NATIONAL ELECTRIC LIGHT ASSOCIATION, AT CLEVELAND, FEBRUARY, 1895.

The use of fuses for the protection of electric circuits has proved unreliable and unsatisfactory. The adoption of magnetic circuit breakers being, as it is, a foregone conclusion, led the writer to make a study into the requirements entering into what would constitute a technically correct form of magnetic circuit breaker.

In a circuit entirely or partially inductive, a sudden increase of current is checked by the impedance of the inductive part of the circuit. The rise in current, with the time, is illustrated by curve No. 1 taken from Bedell & Crehore's work on alternating currents.

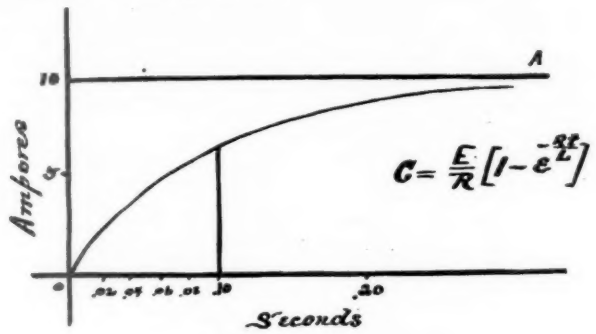


Fig. 1

This curve gives the rise in current, with time, in a circuit whose resistance is .1 ohm and coefficient of self-induction is .01 henry.

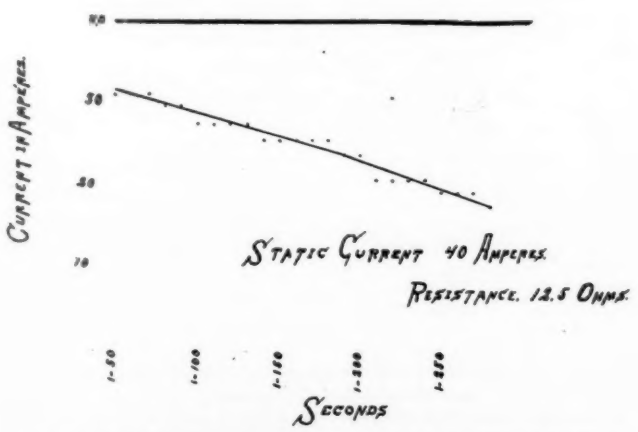
The curve is based on Helmholtz's formula

$$C = \frac{E}{R}(1 - e^{\frac{-Rt}{L}}) \quad \text{wherein}$$

C = Current in amperes.
E = Applied Electro-motive force.
R = Resistance in ohms.
e = Naperian base of logarithms.
t = Time in seconds.
L = Coefficient of self-induction in henrys.

This is a logarithmic curve and from the character of the formula, which is an exponential function, the practical interpretation has very seldom been appreciated by the practical operators of electrical apparatus. The utilization of the principle embodied in Helmholtz's formula gives the solution to the problem to determine the correct method of protecting electric circuits. The use of fuses for the protection of circuits has proved to be so antipodal to the fundamental principle contained in what is the severely technically correct method, that it is criminal, almost, in the light of present practice, for users to follow like sheep in the path of their predecessors in the use of fuses. The practical interpretation of the above formula indicates clearly that if a circuit be opened during the rise or first surge in current upon a tendency for abnormal flow, and further, if the time of opening be made as quickly as possible, the less the resulting flow of current will be.

Fig. 2.



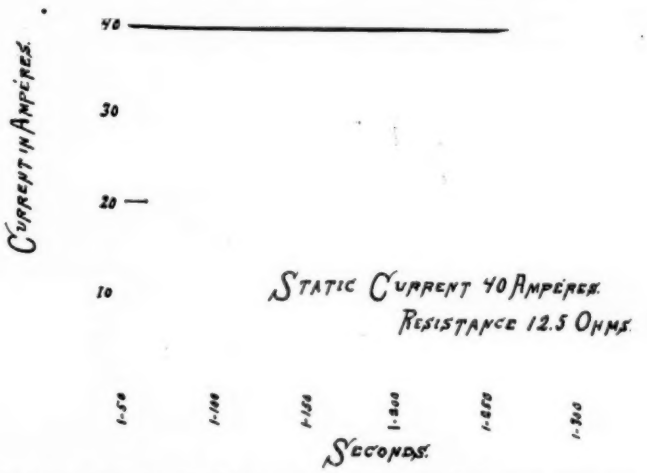
To realize the importance of this time element in the opening of a circuit, if we refer to curve No. 1, it is apparent that if the circuit were opened in $\frac{7}{100}$ of a second, the current would be only $\frac{1}{4}$ the strength it would be if allowed to flow until it had reached the volume due to ohmic resistance alone.

It will also be noticed that if the circuit were opened in $\frac{3}{100}$ of a second, the current would be about $\frac{1}{4}$ its final value.

To eliminate mathematics, and that most elusive of all electrical units to grasp, the henry, and to illustrate in every-day amperes the effect time has upon opening a circuit in a working power-station, wherein exists the self-induction of the dynamos and station appliances, and the small negligible self-induction of the measuring instruments used in testing—tests were made in the power station of the Camden Horse Railroad Company as follows:

In order to vary the current for making the tests, a non-inductive resistance, to wit, a water rheostat. was employed. The use of a non-inductive resistance for varying the current would not introduce factors to prevent the results from representing what would actually occur upon corresponding changes in condition of circuits with time such as would occur in practice.

Fig. 3.



In fact, in the majority of instances, the results would be even more pronounced than those shown in tests, as there would usually be inductive resistances in circuits.

Fig. 7. A vertical iron rod having a sliding contact dropping from different heights and making contact with a fixed wiping contact, completed a circuit for varying but pre-determined periods of time, dependent upon position of sliding contact before dropping.

By carefully calibrating the device for the time of contact by the sliding contact, using the fundamental law of gravitation.

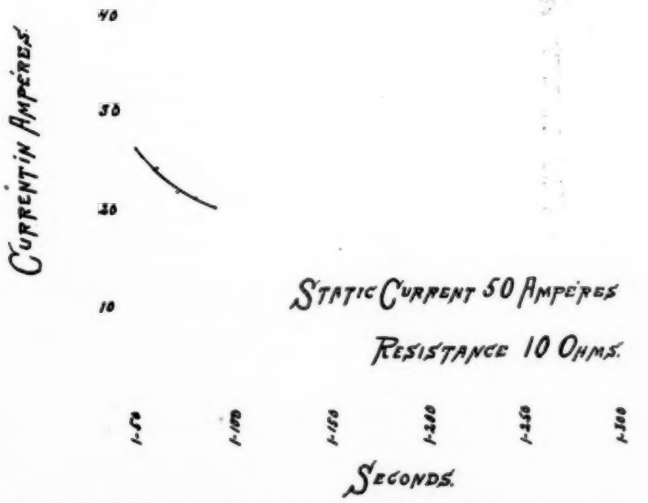
$$t = \sqrt{2gh} \quad \text{whence}$$

t = Time in seconds.
h = Height of fall in feet.
g = Acceleration due to gravity = 32.2 feet.

A means was thus at disposal for determination of time for making of circuit for $\frac{1}{50}$ of a second to $\frac{1}{250}$ of a second in steps as follows: $\frac{1}{50}$, $\frac{1}{60}$, $\frac{1}{80}$, $\frac{1}{100}$, $\frac{1}{250}$ of a second.

A Weston standardized ammeter was employed for adjustment. By placing the sliding contact to touch the fixed wiping contact, a circuit was completed through an adjustable water rheostat, permitting the flow of a pre-determined current, after which circuit could be opened by an auxiliary switch. The sliding contact could then be set at a point, by dropping from which the time for completing circuit was as desired. In circuit was a carefully

Fig. 4.

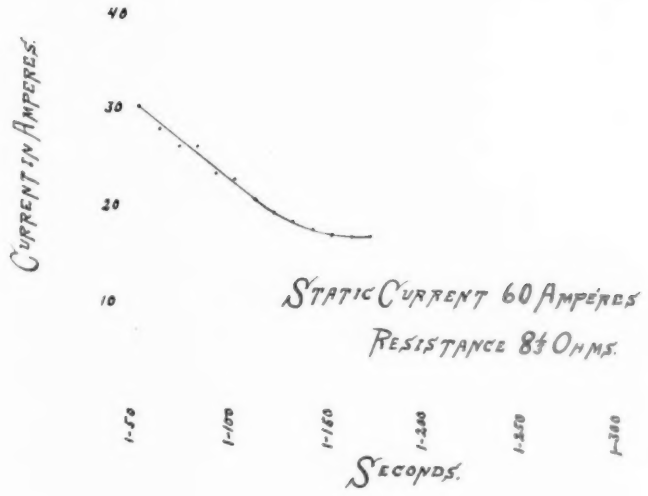


calibrated C-S magnetic circuit breaker, used as an ammeter and subject by adjusting screws to open on different currents. By letting sliding contact drop a sufficient number of times to find the adjustment of the C-S magnetic circuit breaker which the current flowing would not open, also the adjustment at which the current would open it, gave a means for knowing conclusively that the current actually flowing would be between the two indications of the circuit breaker. By continuing this operation for the same static current for the different periods of time within the limits of the testing device, the series of value thus obtained could be plotted out, showing graphically the differ-

ences between the current which would flow for continued periods of time, due to the applied electro-motive force and the given ohmic resistance of the circuit, and the current which actually flows for the very short period of time established by the wiping contact. The effect of impedance is illustrated so excellently for a continuous circuit having an initial voltage of 500 volts, with currents ranging from 40 amperes to 70 amperes and in 10 ampere steps, that it will appeal at once to all as a striking object lesson. Figs. 2, 3, 4, 5, 6, show clearly the impedance effect.

Fig. 2 illustrates the values of current for the different periods of time current can flow, ranging from $\frac{1}{240}$ second to $\frac{1}{50}$ second, when the ohmic resistance of the circuit is 12.5 ohms.

Fig 5.



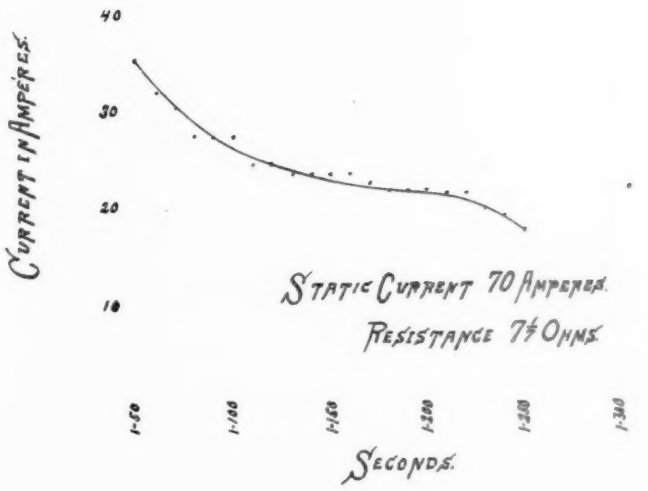
This test was made without any effort to overcome the arcing attendant upon opening the circuit.

Fig. 3 illustrates the values of current under similar conditions, as illustrated by Fig. 2, except that an air blast was employed to blow out the arc following the opening of the circuit. The difference in eighteen results obtainable between tests two and three in the use of an air blast was so pronounced that it was employed in the remainder of the tests.

Figs. 4, 5 and 6 are curves illustrative of tests when the ohmic resistance of the circuit was respectively 10, 8.3, 7.1 ohms.

To appreciate the meaning of the curves, the full black line is the line showing the value of current if the circuit be closed for any extended period of time; the difference between the straight heavy line and the curved line shows clearly the effect the time of opening a circuit has upon a typical power plant.

Fig 6.

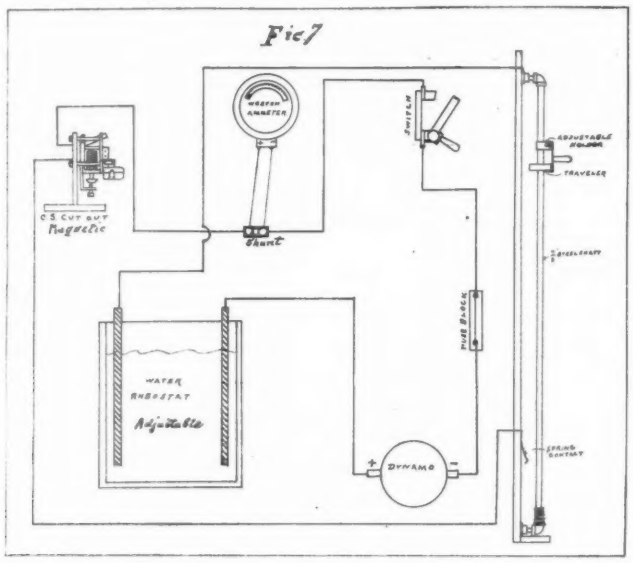


The heretofore standard form of magnetic circuit breaker, and the type familiar to all, is immeasurably preferable to fuses, in so far as it opens the circuit much quicker on the score of time. Fuses open the circuit so late after the heavy unusual condition of circuit is established, that the current reaches the high and parallel part of current curves. For illustration, curve No. 8, in which we assume current has been flowing at, say, 100 amperes, with a 150 ampere fuse to protect the circuit, suppose a short circuit occurs, making a condition wherein 1,000 amperes would flow owing to ohmic resistance, if not checked.

The fuse would not blow until the current had at least reached point B on curve, or some point beyond. The ideal point to open the circuit should be as near the point A as would be possible.

While the regular well-known types of magnetic circuit breakers open before fuses do, still they are not what they should be, when the heavier, more abnormal short circuits occur on circuits, for the reason that the magnetic circuit breakers as at present constructed have practically an unvarying fixed time element; that is, they open in the same time whether the condition of circuit be such as to just permit the passage of current required to open the circuit breaker, or the condition of circuit be such that the passage of current is due to a short circuit.

Fig 7



The opening of the magnetic circuit breaker, as constructed, depends either on springs or gravity; the role the magnetic feature plays is simply to allow either the spring or gravity to act on the switch.

A magnetic circuit breaker should be constructed to open the circuit in less and less time as the conditions become more and more severe. This can be done by taking advantage of the flux of lines of force due to the passage of the current, since, fortunately, the two are simultaneous; and by designing the magnetic circuit breaker to open as regards time in an inverse ratio to the increase of the lines of force, and not depending on the springs of gravity, except, possibly, as auxiliaries to act as potential energy to aid in overcoming the inertia of the switch jaws and arms. We have then the correct method of protecting electric circuits.

The destruction of electrical apparatus, the breaking down of insulation, the burning out of circuits, is taken by the business managers of electrical stations with a meekness and a non-effort for relief which is astonishing. What business manager would permit his boilers to run with safety-valves of such a type that an increase of 500 to 1,000 per cent. of pressure would be required to open them?

The writer has repeatedly made tests showing that a No. 21 B. and S. gauge copper wire would permit the passage of 450 amperes for $\frac{3}{1000}$ of a second without burning out, without changing color. This is significant, as it shows that under conditions in practice the mechanical shock or torque tending to wrench or rupture insulation would be present in a marked

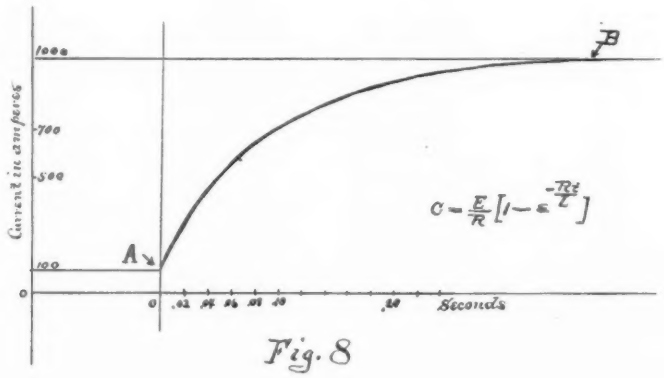


Fig. 8

degree, and further faults and flaws would develop which would by recurrence eventually cause the break-down in insulation. Owing to the sluggishness of fuses, permitting current to rise to the level point of current curve, wires under insulation in machines, as well as building wiring, unquestionably at times become red hot. I have seen wires become heated momentarily red hot, and cool off immediately after current was checked.

How many unknown, mysterious fires have started from this cause in electric wiring circuits?

All switchboards and minor lighting circuits should be protected by automatic (as regards time element), magnetic circuit breakers, and the urgency of this will appeal to the exchequer of the management of our many electric light and power stations when the full meaning and import of Helmholtz's law dawns upon them.

(Concluded from page 104.)

about as sensible to compare European telephone rates with American as to compare the price of a London ready-made suit with that of a suit made by a Fifth avenue tailor. The cost of production is quite different and so is the result.

Yet, on the strength of such loose and ignorant comparisons the legislature is asked to fix a rate for telephone service in New York city which would yield about one-half of the actual operating expenses. Up to last Tuesday the legislators had heard only the supporters of the bill. Now they have learnt something of the other side of the shield, and as men of common sense they must feel that the proposed act had not been so well considered as its sponsors had avowed. The withdrawal of the bill for amendment after the first criticism is a full acknowledgment that those who drafted it do not understand the business they aim to regulate. We venture to state that the public demand for telephone legislation has been grossly exaggerated, and such demand as has been voiced has been based on misrepresentations.

Wall Street and the Electrical Stock Market.

The turn taken by financial affairs this week has afforded great encouragement to business interests of all classes. The bond transaction has been practically completed, and the enormous demand for the bonds, amounting to 20 times the amount available in London and 10 times the amount to be sold here, raised the credit of the government both at home and abroad. The most direct benefit which will accrue from the transaction will be a restoration of confidence in the ability of the government to maintain all forms of its money on a gold basis. This is already being reflected by a disappearance of the premium on gold, a cessation in the demand for gold in exchange for greenbacks, and a disposition to re-deposit gold in the Treasury. The powerful syndicate purchaser of the bonds agrees to do all in its power to stop the export of gold and its withdrawal from the Treasury in exchange for greenbacks. The result must be a start towards the revival of confidence—the first step requisite for business improvement.

The change has been reflected by an improvement in the demand for municipal and railroad bonds of the better classes and in a less disposition to bear stocks.

Electrical stocks have been very quiet. General Electric showed some rallying power, gaining about 1 point and closing close to 29⅝. In a talk with an executive officer of the company, I learn that the annual report has not been completed and that it will be circulated to stockholders about May 1. The directors have taken no action during the year looking to a correction of the impairment of the capital, and will make no recommendations in their annual report on the subject. They have tacitly agreed to allow the company to work out its own salvation, if possible. There can be said to be no prospect of any change in this policy during the ensuing year. Consequently it can be assumed that a resumption of dividends on the preferred stock, which are cumulative, are a long way off. This stock was held strongly at 66 up to Friday as against a bid price of 61, when a sale was made at the latter figure. The bonds showed considerable strength, advancing to 90.

Edison Electric Illuminating, which declined to 95½ last week on a forced sale of a few lots, reacted to 99 on limited transactions.

On the Boston Exchange Bell Telephone developed considerable strength, advancing from 191 to 194. New England Telephone was stronger at 66¾, Erie Telephone advanced 2 points to 48½; Westinghouse securities weakened somewhat, the common stock being 30½ bid and 32 asked, and the preferred 48½ bid and 49 asked.

President Barstow, general superintendent of the Edison Electric Illuminating of Brooklyn, says that in five years the company's plant has increased from 18 miles of underground and 6,000 lamps to 90 miles of underground and 128,000 lamps. Extensive construction is to be executed during 1895. The outlook for the coming year is most encouraging. Operating expenses have been kept within 42 per cent of the receipts. The report for the year shows:

	1894.	1893.	Changes.
Gross earnings	$421,074	$325,434	Inc. $95,640
Expenses and taxes.	234,198	178,861	" 55,337
Net earnings	$186,876	$146,573	" $40,303
Other income	36,539	22,485	" 14,054
Total	$223,406	$169,058	" $54,358
Deduct:			
Interest on bonds	$ 25,000	$ 25,000	.....
Dividends	168,750	98,275	Inc. $70,475
Total	$193,750	$123,275	" $70,475
Surplus	29,656	45,783	Dec. 16,127

The same company reports for January net earnings of $25,764, an increase of $2,182. Deducting interest on bonds, the amount applicable to dividends as a result of the month's operation was $23,664. BAIN.

New York, February 23, 1895.

Receivers for the Electric Construction and Supply Company.

Thad. T. Grover, of New York city, and Chauncey G. Parker, of Newark, N. J., have been appointed receivers of the Electric Construction and Supply Company, 18 Cortlandt street, New York city, on the application of General Manager Robert B. Corey, who is a stockholder in the company. It is stated that the nominal assets may be nearly sufficient to cover the indebtedness, but that if the assets were put up at forced sale very little would be realized, and the only way of meeting the indebtedness would be by some arrangement between the company and the creditors as to time and forbearance. Deputy Sheriff McGinnis has attachments in his hands aggregating $13,800. Francis R. Upton is the creditor who holds the first attachment on the company's property. It is for $3,516.24.

A very comprehensive catalogue, No. 3, has been received from the Electrical Engineering Company, of Minneapolis, Minn. Everything in the nature of electrical supplies are included in its covers, and the company handles a number of excellent specialties.

Mr. W. A. Stadelman.

Mr. W. A. Stadelman, of the Elwell-Parker Electric Company of America, whose portrait is presented on this page, is most widely and popularly known in the electrical and engineering fields. For four years he represented the Sprague Electric Railway Company in Philadelphia, and then entered into the general engineering business. He afterwards accepted a responsible position with the Niles Tool Works, having charge of their Pittsburgh office and remaining with them until he resigned to accept the very excellent offer made him by the Elwell-Parker Electric Company, as manager of their eastern

W. A. STADELMAN.

office, with headquarters in New York city. Mr. Stadelman will at once come to New York city and open offices, and will represent the Brown Hoisting and Conveying Machine Company and the Elwell-Parker Electric Company of America, both of these companies having their general offices and works in Cleveland. The ELECTRICAL REVIEW congratulates the above named companies on securing the services of a representative so alert, energetic and successful as Mr. Stadelman, and also desires to express its congratulations to Mr. Stadelman on his deserved advancement along lines in which he is so well fitted to win high honors.

President Harrison Wins.

At Terre Haute, Ind., one day last week, Russell B. Harrison, president of the Citizens' Electric Light Company, won a complete legal victory over the rival Terre Haute Electric Light and Power Company, which had obtained a temporary restraining order against Mr. Harrison's company erecting poles in the streets in violation, as was claimed, of its franchise, and to the interference of the poles of the old company. Judge Henry dissolved the injunction, and Mr. Harrison immediately started several hundred men to work to complete the wiring of the city. Mr. Harrison's company has the contract to light the city for five years.

At a very enthusiastic meeting of the stockholders of the West Shore Telephone Company, Kingston, N. Y., the following directors were elected: Dr. C. O. Sahler, F. D. Winne, Henry Abbey, Enoch Carter, Dr. R. R. Thompson, Clarence Schoonmaker, Kingston; H. C. Tillson, M. A. Presler, Highland; W. S. Ransley, G. S. Clark, Dr. W. B. Snow, Milton; Davis Winne, The Corner; A. L. F. Deyo, Gardiner. The Colvin telephone will be used.

ELECTRICAL NOTES.

At last it has come. Long distance telephone subscribers can now talk to Kalamazoo.

A new telephone company is being talked of in Albany, N. Y., to furnish local service.

The Bell Telephone Company interests, after a vain struggle to run the Finch exchange out of Escanaba, Mich., has abandoned the town, at least for the present. "Poor boy Finch" still has that cinch.

Efforts are being made to establish a new local telegraph line between Athens, Sayre and Waverly. A committee, it is said, now has the matter in hand and is taking the names of persons who will use the system for the term of two years at the rate of $24 per year.

A charter has been applied for by Blairsville parties for the Blairsville, Pa., Telephone Company. The incorporators are M. C. Kerr, J. A. Graff, Freem. Wilkinson, J. B. Carson, A. M. Baker, J. M. Harvey, E. J. Graff, A. B. McCabe and Thomas Maher. They will establish a local telephone system in Blairsville.

The Southern New England Telephone Company held its annual meeting and elected the following directors: Morris F. Tyler, A. Heaton Robertson, William E. Downs, John W. Alling, S. E. Merwin, James English, of this city; Lyman B. Jewell, of Hartford; S. A. Morgan and Thomas Sherwin, of Boston, Mass.

At the annual meeting of the Southern Massachusetts Telephone Company the following officers were re-elected: Clerk and treasurer, Samuel Ivers; directors, Charles W. Clifford, Oliver P. Brightman, Walter Clifford, Morgan Rotch, Samuel Ivers, William H. Forbes, Thomas Sherwin, Edward D. Mandell and Frederick Grinnell.

The annual meeting of the stockholders of the Central New York Telegraph and Telephone Company was held last week at Utica. The reports cover both the Utica and Syracuse exchanges, as well as smaller ones connected by the company's wires. The report of the directors to the stockholders was submitted and read. The total number of subscribers is 2,951, a gain during the year of 66. To make this gain 484 telephones were placed and 418 removed, making the total number of changes 902. Number of miles of wire in the exchanges, 2,233; miles of wire in toll lines, 3,335; number of employés, 122. Four quarterly dividends of one and a half per cent each have been made, or six per cent in all, during the year. The average cost of each call to each subscriber in Utica is two and three-tenth cents. The old Board of Directors and the old officers were all re-elected.

A HUGE SUCCESS.

(*Continued from page 102.*)

stated further along, where we apply it to a station and change the character of our load line, that the amount lost is only that part of the energy stored in the battery at that time and has no reference whatever to the other units working below it. The figures stated by me are less than those given by the Electric Storage Battery Company.

Mr. Edgar: We have been operating for the past year one of the largest storage batteries in the world. I think that I can answer a number of the arguments made in the paper, but not having seen it until the reading cannot do it in detail. We pay for a 400 horse-power battery six per cent on the cost of the cell, which is about four per cent of the cost of the installation, and for a 10-year guarantee. [Applause.] As the result of putting in the first battery a year ago we are now putting in one double the size, so that we own to-day the largest in the world. The original battery was put in after a personal investigation abroad, and I do not see how anyone can go abroad and look at the batteries that are used there and have any hesitation whatever in putting in a battery, if you get a guarantee. It has never entered my head in the slightest degree as to whether a battery was economical. The only question which has come up has been, Can you get a battery which will not deteriorate? We are saving ten per cent of our coal bill by a battery costing per horse-power one-half as much as our steam plant. We have in one of our stations a 600 horse-power engine. We have four of them. Our maximum load, purely Edison three-wire system, lasts for an hour and a half. I asked for specifications for a battery which would run 600 horse-power one hour and a half. Having nothing to go by for American practice, I asked for a battery to duplicate one of our steam engines. A first-class steam plant costs $100 a horse-power, everything inside of the building. That is being done to-day. That battery cost us a little over $50 a horse-power to do the maximum work. We did not want it to do it for 12 hours. That would be the point Mr. Perry speaks of. We did not need it. We bought it for service during one hour and a half. Looking at it on that basis, we can save 50 per cent, or half of the money, by putting it into batteries, so that our total investment in the station, with half batteries and half steam, is only three-quarters of what it would be if all steam. We bought the battery to take care of the maximum load, and have never used it for anything but the maximum load, and we still save 25 per cent. This is all assuming that the battery will be made to work and you can get a guarantee. We succeeded in getting a 10-year guarantee from a firm absolutely reliable, one of the old firms in Germany, for a battery, which, for six per cent on the cost of the cells, not the switchboard or copper bars, they will take care of it. Up to the present time they have not spent a cent. That does not mean much, because it has only been running a year. The operation has been in the hands of a German whom they sent here, who gets $12 or $15 a week. The discharge is only for one hour and a half.

Mr. Perry: If they were stored for 12 hours and run for 12 hours the cost would be doubled or trebled.

Mr. Edgar: Those conditions do not exist. I take the conditions as they exist in business. I do not know any condition such as you have shown in the electric lighting business.

Mr. Perry: The result would be as I have shown—too expensive.

Mr. Edgar: That would be running a battery with a steam annex, instead of *vice versa*. There are no stations running currents such as you have referred to. Your load curve is incorrect.

Prof. Houston then read the paper "A New Method of Measuring Illumination," prepared by Houston and Kennelly. It will appear in a subsequent issue. The paper was discussed by C. D. Haskins, Prof. Elihu Thomson and the authors.

A letter of invitation from the Cleveland Electric Railway Company was read, extending to the delegates the courtesies of the street cars during their stay in the city.

The Cleveland Telephone Company tendered the free use of its local and long distance lines to all points to the delegates.

Letters and telegrams of regret at their inability to be present were read from Howard W. Sexton, Charles W. Price, Sylvanus P. Thompson, Marsden J. Perry, Nikola Tesla, Governor William McKinley, George Westinghouse, Jr., and C. A. Coffin.

Adjourned.

WEDNESDAY—Morning Session.

The President called the meeting to order at 10:15 o'clock. The first business transacted was the reading of the report of the Finance Committee. The report showed that the receipts during the fiscal year had been $5,996.69; expenses, $5,449.95, leaving a balance of $548.74. Mr. Seely, chairman of the committee, reported that there were no liabilities against the association.

Paper of W. E. Harrington on "The Correct Method of Protecting Electric Circuits" was read, and it appears elsewhere in this issue.

The paper by Mr. C. N. Black on "Large Arc Dynamos" was then read.

The President called upon Mr. S. M. Hamill. He said: I naturally was very much interested in Mr. Black's paper. A man who sat for a number of years at the feet of such men as Professor Brackett, of Princeton, and Mr. Brush, of Cleveland, ought to be able to write a pretty good paper. My interest in these large dynamos is purely from the standpoint of the manufacturer and seller. During the past year I think the Brush company has built large arc dynamos, from 8,000 to 10,000 lights capacity. The inquiries concerning them do not come in from the new installation companies, but almost entirely from existing stations. This is natural, for the reason that nearly all our large electric light stations are quite centrally located in the large cities of the country, where real estate is expensive, where the business is growing, and where it is a question either of going away further from the center of the cities or purchasing additional real estate at great expense in order to increase the capacity, or to exchange the small dynamos for larger ones. I have in my mind, for instance, one of the largest and best managed local companies in the country, where they have two large stations quite near each other in the center of the large city, stations that have been in existence 13 to 14 years, where last year they had 2,000 lights' capacity, and arc dynamos ranging from old 10 lighters up to 60 lighters, using a tremendous amount of shafting and belting, and, naturally, they were inefficient dynamos. This company exchanged all their old dynamos, small and large, for a complete new outfit of 12 or 13 large dynamos, and by so doing they obtained a great deal of space in existing stations for increasing their business, without going to the expense of enlarging their areas. I have in mind another station where they had almost exclusively 50 to 60-light arc dynamos with a capacity of about 2,000 arc lights. This station changed from 50 to 60-light dynamos to 125-light dynamos, and saved a large amount of floor space and increased the efficiency of their machines, which is a very telling point. The field, as far as manufacturers are concerned, at the present time is almost entirely along the line of exchanges from the small to the large units, and there is very little profit in it for the manufacturer.

Professor Thomson: I have been quite interested in listening to the paper, as I consider it a very true exposition of some points connected with the operation and design of arc dynamos. The development of the arc dynamo, it is true, has been somewhat backward; still, I do recollect that machines were built far back in the early days which were capable of giving a curve similar to that which has been shown, a characteristic curve, but they were disadvantageous from the very large armature reaction, the size of the armature, the amount of wire and the dead resistance of the wire used in the construction. The question as to whether open coil dynamos or closed coil dynamos are the best for arc lighting has been fully discussed in the literature of the subject for a long time. Considered purely as an electrical affair, without reference to the practical uses, there can be no question but that the closed circuit dynamo is the better electrical structure. I say considering it simply as a dynamo; but when you come to use that dynamo in the conditions of practice, there may be considerations which will modify that conclusion. I am really sorry that Mr. Wood is not here, the champion of the closed circuit dynamo. We might have had a discussion bringing out the strong points of the other side. When I first entered the business, my object was to get that kind of a machine which, put into ordinary hands—men of no experience with machines of the kind—could be run successfully and keep the lights going, and the object was to reduce to the utmost simplicity those parts which were subject to wear and which could be injured by bad handling. Therefore the commutator was reduced to very few parts and it was constructed so that if anything happened to it, to injure the segments, it was a simple thing to take off the segments and put on others. That could not be done if the commutator contained from one to two hundred segments. In that case, it would mean that you would have to take out the whole commutator and lay it aside and get a new one, and make all the connections before you could start the machine. In the early history of dynamos, we did not have experienced men to handle them. The dynamos were not put in stations with a dynamo tender of experience in charge. They were in charge of an engineer, who might know how to run his engine, but knew nothing about the dynamo, and who had a superstitious idea that that was a thing which he must not touch. We have had enough cases of this kind arise. In one case the brushes on the dynamo would not rest on the commutator and we had a communication that something was the matter with the machine and we were to send the best expert we had right along! The moment we go into a new field we have to educate men to understand how to handle the new structure on account of its peculiarities. The fact that an arc dynamo, when it has its circuit interrupted, will not give the rise of voltage which the continuous dynamo gives, has been known for a long time.

The point of flashing was admirably brought out in the paper. The moment you begin to open the circuit of a machine it is the same thing as overloading; that is, you are putting in a high resistance. The arc follows, amounts to so many arcs put in resistance. The potential, on account of the self-induction of the wire coils, at once begins to rise with the attempt to hold a diminished current. If at that moment the commutator, owing to its arrangement and construction, flashes over, arcs across from one side to another, you have removed the electro-motive force of the armature, and if the machine, as is often the case, has a copper band in the field poles, then we have an inductive circuit parallel with the field winding which takes out the inductive electro-motive force from the field coils, and it is not surprising that there should not be a great rise in a case of this kind. Long ago the natural practice was that when we ruptured the circuit of the open coil the flashing did not extend any great distance, but it was a well-known fact if you had a close coil the circuit of flash was much longer.

Mr. Townley: There is one phase of the question which I should be glad to have the opportunity of stating to the members. It has been my fortune to be in a position where the demand for large units for lighting has been heard from very quickly, and I can confirm Mr. Hamill in his statement that the pressure is very strong for large units for arc lighting. The reason why arc lighting machines seem to have been made small for so long a time is possibly not easy to answer, but it may be found in the fact that until very recent times it has been very difficult to insulate for the corresponding potentials. Looking at the problem of furnishing a large number of arc lights to a community, from one of our modern central stations, it is evident that if the conditions were not so severe as to render it otherwise, it would be advisable not only to use a machine as large as 100 or 125 lights, but in fact machines of larger capacity and insulation, of 1,000, 2,000 or 3,000 arc lights. We should manifestly have, if possible, units of larger capacity than 125 lights, and when we get down to 60, 75 or 80 lights the objections are greater. In some cases there have been established stations of units of 200, 300 or 400 lights in one machine; this being done, however, by the use of constant potential in place of constant current machinery. This is necessitated, apparently, by the use of alternating currents, and it possibly has not been brought into more general use on account of the lack of success in starting and operating the alternating current arc lamps. At the present time, however, that objection can hardly be said to exist, and the fact that there are now operating stations of considerable size using this system practically demonstrated the success of it, and is worthy of consideration. Of course, with the introduction of the alternating lamp, and the ability to run power from apparatus of this character, there is a great point to be gained in large cities, particularly where underground work is necessary, when we can supply incandescent and arc lighting and power; in fact, all classes of service, from the same unit; and if that unit be a large unit, we can take advantage of the best economy in steam practice and the higher efficiency in dynamo construction. It seems to me that the development is bound to be in future along the lines of these larger units, and that as the electric lighting public, men who have their money and interests involved in this industry, come to know that this system is a profitable one, successful commercially, and acceptable to municipalities, it is bound to be a very prominent factor in our interests hereafter.

Mr. Hamill: A very interesting point that always arises in this connection is the question whether you can run these large machines on the existing circuits that have been in use for so many years, and I see Mr. Prentiss, who can cite to you an interesting case where these machines were put on some of the oldest circuits in the country.

Mr. Prentiss: I will state that the question of line insulation with the use of larger units seems to be one of care more than anything else. Several instances have been brought to my notice where large machines were put on ordinary circuits, in which very little trouble was experienced, and also that underground work which has been started for high potential will do very nicely. The only trouble which will be practically met would be from the point of the line into the place where the light would be used, in the connecting appliances. The trouble principally arises from the moisture getting down onto the cut-out box. I believe there are very few cut-out boxes which will stand the ordinary high potentials of 3,000 volts where you have a spell of wet weather for three or four days. When that point is taken care of there will be very little trouble. I do not doubt but what existing lines of two or three thousand volts can be made to run at a high potential. It has been demonstrated in several instances to be practical.

Mr. T. Carpenter Smith: Referring to the question of the use of large units on the old lines, I think some of the older members probably remember when in times of trouble they did not hesitate to put two 50-light machines together on a single circuit, which was as much strain on the insulation as a single machine. The most extreme case I know of was fifteen 10-lighters in series for an 18-ampere current. I think that was as much of a strain as would be experienced with any of the large machines being advocated. The old machines were repeatedly speeded up to give nearly the same capacity. I know 40 and 60-light machines running on 60 and 90-light circuits, and the extreme case was probably reached in New York city a few years ago during the time the wires were being put underground, when in one station they ran two 60 and a 30 in series.

Mr. Prentiss: In regard to Mr. Smith's remarks I wish to say that a practical demonstration of what can be done is that in New York city their 240-light machines run on an underground circuit.

An invitation from the ladies of Cleveland extending an invitation to the visitors and their ladies to attend the exhibitions of paintings in the Garfield Building was read and duly accepted with thanks.

Resolutions endorsing the Cotton States and International Exposition at Atlanta, as advocated by the ELECTRICAL REVIEW last week, were offered by Mr. J. A. Seely and unanimously adopted. They appear in full on our editorial page.

WEDNESDAY—Afternoon Session.

The President called the meeting to order at 2.30 o'clock. The first business on the programme was to have been the paper on "The Monocyclic System," but, as it would take some time to rule up the diagrams necessary to illustrate the paper, the president called up the topic, "How to Light Large Cities." None of the gentlemen who were set down to discuss this topic being present, as this was not the time announced to consider it, the president called on Mr. Wilmerding, of Chicago.

Mr. Wilmerding: The cost of lighting in Chicago, according to Professor Barrett's figures of a year ago, if I remember rightly, was $96.25 per lamp. This figure, it was stated, included nothing of interest, depreciation, insurance, taxes, etc., or what in a lighting company would be called expense. In other words, it might be said to include solely labor and material. The cost per lamp installed was something in excess of $500, which at six per cent interest on the original investment would amount to $30 per lamp, and a fair depreciation might be six per cent, which would add another $30, or a total of $60 to the cost; in other words about $156 per lamp per annum. We are furnishing a few lamps to the city at $137.50 per annum, so that as a matter of fact we are supplying lights at a lower cost to the city than they can make it themselves. On that basis it seems reasonable to suppose that large cities should be lighted by private corporations rather than by the city itself. There is no question but that in every municipal organization in this country the cost of carrying on what may be considered a commercial or private business is much greater than where it is carried on by a private corporation, where all expenses are carefully considered.

Mr. Redman, of Rochester: I think the best answer I can give to this question is to give a description of the city lighting by the two companies with which I am connected. The city of Rochester, with a population of 165,000, has 2,010 arc lights on the streets; 1,109 Brush and 901 Rochester. In the center of the city we have one street, 7,940 feet in length, with no wooden poles and no overhead construction except the trolley wire. That street is lighted with 76 pair of eight-ampere lamps, on the Edison system, and give general satisfaction. They are so popular that the cry is for lighting the entire city on that system.

The paper on "The Monocyclic System" was then read by Dr. Bell, and was discussed at some length by the following gentlemen. The discussion and paper will appear in full in a subsequent issue of the ELECTRICAL REVIEW.

Mr. J. F. Kelly, of the Stanley Electric Manufacturing Company, while admitting the ingenuity of the system, thought it had come too late, and was, in view of present conditions, a step backward rather than an advance.

Mr. C. P. Steinmetz disagreed to some extent with the previous speaker, but limited his remarks chiefly to comparisons between the single-phase alternating current system and the polyphase system, whose relative merits he pointed out.

Professor Thomson spoke briefly, endorsing Dr. Bell's paper, and also the position taken by Mr. Steinmetz.

Mr. C. F. Scott followed Professor Thomson, and went into the matter at considerable length, pointing out the advantages and disadvantages of the system very minutely. He was followed by Dr. Bell in a brief résumé of leading points.

The Reception Committee of ladies resident in the city of Cleveland tendered a banquet to the visiting ladies at the Stillman Hotel, and sent a large bank of roses to the convention hall, which was greeted with applause.

On motion of Mr. Seely, a vote of thanks was tendered to the ladies of Cleveland for the reception which was tendered to the delegates and their ladies.

Adjourned.

WEDNESDAY—Evening Session.

Prof. A. J. Wurts delivered an address on "Practical Demonstrations of Protecting Lines from Lightning," which was well attended and received with much approval.

THURSDAY—Morning Session.

The President called the meeting to order at 10 o'clock, sharp.

The report of the Committee on Data was presented.

It was discussed at some length by Mr. W. R. Gardener, Mr. E. L. Powers, Mr. A. E. Armstrong, Mr. H. M. Swetland, Mr. Jennings, Mr. Hadley, Mr. J. J. Burleigh, Mr. Burhn, Mr. J. I. Ayer and others.

All endorsed heartily the work already done, expressing themselves strongly as to the value of such information, properly and thoroughly compiled, and its importance in central station management.

It was the unanimous sentiment of the meeting that the work along these lines should be extended as rapidly as possible, and that data should be gathered of all other essential features in the economical operation of a plant, as well as the important one of coal consumption.

It was recommended by Mr. Armstrong that the committee should gather all possible information from a wide range of central stations, and that its value to each and every one of them should be impressed upon the managers. Mr. Ayer presented a resolution that blanks should be sent out containing full instructions for obtaining this in tabulated form.

This resolution was adopted, and vote of thanks tendered to the Committee on Data.

At the executive session, which was held at this time, the report of the Committee on Relations between Manufacturing and Central Station Companies was fully considered, and the following special committee appointed in connection therewith: Messrs. A. J. De Camp, John I. Beggs, E. A. Armstrong, T. Carpenter Smith, F. Gilbert. Messrs. Seely, Armstrong and Colburn were appointed a committee to nominate officers for the ensuing year. Messrs. Ayer, Nichols and Burleigh were appointed a committee on resolutions. The constitution was also amended, providing for the holding of one meeting in each year, in the months of May or June. A motion was passed recommending that the next meeting be held in New York city.

The paper by L. B. Marks, "Arc Carbons and the Rating of Arc Lamps," was then read and discussed by Messrs. Peck, Ayer, Armstrong and Marks.

The report of the Committee on Rules for Safe Wiring was then presented, as follows:

> At the last meeting of the association the rules were carefully revised, and, in the opinion of your committee, but slight changes could be desired. Recent work of your committee indicates that in the near future joint meetings will be held with committees of the underwriters, street railway association, telephone and other interests, which will be productive of much good, and will enable a very satisfactory report to be made at the next meeting. In view of the above, your committee recommend that the present rules will be approved and continued.
>
> W. J. HAMMER, Chairman,
> J. I. AYER,
> H. M. SMITH.

The President called upon Mr. C. J. H. Woodbury, of Boston, to discuss the report, who said: As the report of the Committee is so direct and clear, and the time of the Association at this stage of the meeting is so valuable, I do not feel like trespassing upon it with anything in the line of a discussion. This subject is one of infinite detail, which must necessarily be carried out in the hands of committees, who can give long and detailed attention to the several matters that are brought up, reaching out into every application of electricity. The rules pertain to every element of application of electrical apparatus, no less indeed to the harmless telephone wires than to the apparatus producing the infinitely greater currents. It is here that the interest of makers of apparatus, operators of plants, the owners of property and the patrons of all electric companies concentrate, and, therefore, it goes without saying that there is every reason why there should be a unification of rules for a unity of purpose. These interests have naturally different relations to these rules. While in the initial steps in the construction and operation of apparatus the members of this Association have the fundamental relation to these rules, yet their subsequent action in regard to their application is not so general. Adjourned.

THURSDAY—Afternoon Session.

President Francisco called the meeting to order promptly at 2.30, and said that certain members desired to hear the experience of central station managers with reference to the Welsbach burner.

Mr. Gardner: In the city of Pittsfield there are at the present time about 250 of these burners in use. I understand that more have been ordered, but the agent has not been able to supply them. A dentist in North Adams was operating upon a patient under the light of a Welsbach burner when the lamp exploded and embedded pieces of glass in his cranium. I immediately investigated the subject and found that he was no longer using it. We had a customer who was using our lights in his store and workshop, and he substituted the burner in his store, but not in the workshop, the reason being that the hammering of his workmen on the benches caused a vibration, which would gradually shake the mantle to pieces.

Mr. Edgar: We have had as much experience as any other city, but to sum up a long story, I will say that the burner is gradually disappearing. We have just completed a contract with a large store, which is going to take out the Welsbach and put in our lights. We have a letter from a drug store, stating in emphatic terms what the proprietor thinks of the Welsbach. Often when his store door opens the mantle breaks from the draught of cold air. We are naturally prejudiced against the burner and want to see it disappear; but leaving that out of consideration, I should say the burner is losing ground in Boston within the last six months.

Mr. Cairnes: In Memphis we became very much alarmed. They displaced probably 1,500 to 2,000 lights in from 30 to 60 days, and no amount of argument could stop the storm of popular favor in the direction of the Welsbach; and we sat down and mused over the possibilities of an assignment in the near future. That was about a year ago. I presume we have back from 50 to 60 per cent of the patrons we lost by the burner, and I have assurances that we will get back as much as 25 or 30 per cent more within the next two months. They have lost ground in Memphis as rapidly as they came in favor.

Mr. Seely: I do not think it is a very serious menace to the electric light business where people are at all discriminating as to the character of light they get. In smaller towns people are not as discriminating as they are in the larger cities. It seems to me that one of the things the local companies want to do is to maintain better service themselves. One of the reasons that encourage the use of the Welsbach burner is that in some places the service of the electric light companies is irregular.

Mr. Peck: Our station in Brooklyn is almost entirely given to arc lighting. I noticed some four months ago that about 25 large stores used the Welsbach burner. I noticed the same stores a week or two since and discov-

ered that 10 out of the 25 have gone back either to simple gas or the incandescent light.

Mr. Armstrong: This is very encouraging to us. The fact of the matter is that electric light is a luxurious light; and it will compete, perhaps, with gas in larger quantities, but it will not with the small consumer. That is the thing we must face. The practical difficulty is that it does not pay us to supply very small consumers; it does not pay for the installation, the meter and all that. I am pleased to hear from Memphis and Boston as to what has been the history of this thing; but so far as our incandescent business is concerned it has been and is now a very serious problem. We lost during the last quarter 75 customers, and we do not see any cessation to it. I hope to report by next year that the number has been diminished in accordance with the statements made from other cities.

Mr. Stetson: I know a town a little north of Boston where I heard the manager say if he could have seen the Welsbach burner before he bought his electric light plant—he manages both wings of the service—he never would have troubled himself about the electric plant, and is only hoping that the municipal lighting scheme would come along and buy his plant. You cannot compete with gas in small towns under 25,000 inhabitants. In the larger cities the electric light can hold its own. I find the greatest annoyance in our community to come from the multiplication of the oil wagons. The Standard Oil Company has put up a very large tank, holding thousands of barrels of oil, and they run out wagons just as the milk peddler does; and as our cities in the East are largely composed of people working in factories, there is no hope of our trying to get anything out of them with the electric light. If we could only increase our product we could decrease the cost; but there is no hope of this in those communities.

Mr. Corriveau: I do not think there ought to be much alarm felt about this Welsbach burner, or what we call in Montreal the oil light. I do not think there is a city in America which is provided with so many of these burners as Montreal at the present time. They have had them about a year and a half, and several thousands of them are in use, but I am pleased to state that to my personal knowledge eight or ten large stores have gone back to the electric light, and the reason is that they are completely displeased with the burner on account of the breakages of the mantle and the bad color of the light, and I believe it will only be a short time before this will be general.

Mr. Francisco: We had a customer who put in the Welsbach, and after using them a month returned to the electric light. I asked the reason, and he said: "I had about 200 of those burners, and I wanted to sell them, but I do not propose to lose on my own light the profit that I made on those burners."

The Committee on Resolutions offered the following:

That the thanks of the association are hereby tendered to Mrs. Sidney Short and the ladies of the local committee, to Mr. Wason and the gentlemen of the Reception Committee, the Cleveland Telephone Company and the Long Distance Telephone Company, the Cleveland City Railway Company, the Cleveland Electric Railway Company, and the gentlemen of the local press.

The many courtesies extended to the visiting members of the convention have been fully appreciated, and the result has been that this Cleveland meeting will be remembered as one of the most pleasant, from a social standpoint, and also one of the most interesting and instructive in the history of the association.

The resolution was unanimously adopted.

The Committee on Nominations presented the names of the following gentlemen:

President, C. H. Wilmerding, Chicago, Ill.

First Vice-President, Frederic Nicholls, Toronto, Canada.

Second Vice-President, E. F. Peck, Brooklyn, N. Y.

New Members of Executive Committee—E. H. Davis, Williamsport, Pa. (one year); W. R. Gardner, Pittsfield, Mass.; George A. Redman, Rochester, N. Y.; J. J. Burleigh, Camden, N. J.

The gentlemen were duly balloted for and elected.

President Francisco: Gentlemen of the National Electric Light Association — In resigning my duties as president of the association, which office I have filled during the past year, I wish to tender to the members for the sincere and generous support I have received, my heartiest thanks. I have been courteously treated in all the dealings I have had with the members and been assisted in many ways, which has been duly appreciated. I expect as a private to do all that I can for the association, and I think it is unnecessary to say that you will find me first, last and all the time assisting the central station managers in all departments. [Applause.]

Mr. Armstrong: I move, with the unanimous consent of the members, that the next annual meeting of this association be held in the month of May or June, as selected by the Executive Committee in the year 1896. Carried.

On motion, adjourned.

C. H. WILMERDING.

THE NEW PRESIDENT OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

Mr. C. H. Wilmerding, the new president of the association, whose portrait appears on the first page of this issue, is the general superintendent of the Chicago Edison Company. He has served on several important committees and has been second and first vice-president of the association.

Mr. Wilmerding is a native New Yorker and was born in 1858. He was educated in Germany and France and afterward was graduated from the Sheffield Scientific School in the class of 1879 as a civil engineer. He was employed in waterworks construction at Troy, N. Y., and spent two years as a mining engineer in Leadville, Col. After this he went into railroad work and built several important lines for the Rio Grande and Western Railroad.

Mr. Wilmerding served as an assistant engineer on the new Croton Aqueduct in New York city in 1884 and 1885. He followed the profession of civil engineering until 1888 and then took up electrical engineering, locating in Chicago. In the Fall of 1888 he was made superintendent of the Chicago Arc Light and Power Company and subsequently became general manager of the company. In 1893, when the Chicago Edison Company absorbed the Chicago Arc Light and Power Company, Mr. Wilmerding was made general superintendent of the Company's operating department, a position of great responsibility in view of the company's extensive lighting business.

The new president is calm and dignified in bearing and should make an excellent presiding officer, and will be an earnest worker in behalf of the association.

CLEVELAND'S GUESTS.

NAMES AND OCCUPATIONS OF THE MANY HUNDRED ELECTRIC LIGHT CONVENTION ATTENDANTS.

The fine special train that left New York city at 9.30 A. M. Monday, February 18, consisted of one combination, three parlor and one dining car, and carried 107 persons. The trip was made without special incident, the train arriving at Cleveland about 1 A. M., eastern time. The party was composed of the following named ladies and gentlemen:

The New York Train.

Almstead, J. A., Citizens' Light and Power Co., Rochester, N. Y.
Ayer, J. I., Marks-Ayer Electric Co., New York.
Alberger, L. R., Henry R. Worthington, New York.
Adams, H. C., Phillips Insulated Wire Co., New York.
Baker, Jr., C. O., Baker & Co., Newark, N. J.
Bergtheil, Edw., Electrical Engineer, London.
Bakewell, Alden C., Interior Conduit and Insulation Co., New York.
Brady, T. H., specialties, New Britain, Conn.
Burke, J., Herrick & Burke, New York.
Baird, M. E., Eddy Electric Manufacturing Co., New York.
Badger, F. H., Montmorency Electric Power Co., Quebec, Can.
Belden, A. J., Belden & Seely, Syracuse, N. Y.
Burns, C. F., Rochester, N. Y.
Crouse, J. B., Crouse-Tremaine Carbon Co., Fostoria, O.
Chesley, C. C., Stanley Electric Manufacturing Co., Pittsfield, Mass.
Coles, Stephen L., ELECTRICAL REVIEW, New York.
Carpenter, C. E., Carpenter Enamel Rheostat Co., Hoboken, N. J.
Coughlin, W. H., Worcester Electric Light Co., Worcester, Mass.
Crani, H. B., Bernstein Electric Co., Boston.
Colvin, F. R., Interior Telephone Co., New York.
Corriveau, A. J., Montreal, Can.
Douglas, S. A., Ft. Wayne Electric Corporation, New York.
Duff'y, Jr., C. R., New York.
De Ronde, F. S., Standard Paint Co., New York.
Davis, H. M., *Electric Power*, New York.
Fairbanks, H. H., Worcester Electric Light Co., Worcester, Mass.
Francisco, M. J., Rutland Electric Light Co., Rutland, Vt.
Francisco, Don C., Rutland, Vt.
Francisco, Jr., M. J., Rutland, Vt.
Flanagan, Thos. J., Rutland, Vt.
Gates, J. J., Perkins Electric Switch Manufacturing Co., Hartford, Conn.
Greene, B. E., *Electricity*, New York.
Gilbert, F. A., Boston Electric Light Co., Boston.
Gallaher, C., National Consolidated Manufacturing Co., New York.
Gardner, F. F., Newark Electric Light and Power Co., Newark, N. J.
Hambey, J. D., Beacon Vacuum Pump and Electrical Co., Boston.
Heinrich, R. O., Weston Electric Instrument Co., Newark, N. J.
Higgins, E. M., Rochester Electric Illuminating Co., Rochester, N. Y.
Hart, G. W., Hart & Hegeman Manufacturing Co., Hartford, Conn.
Harrington, F. W., India Rubber and Gutta Percha Insulating Co., New York
Hatch, E. B., H. W. Johns Manufacturing Co., New York.
Huntley, C. R., Buffalo General Electric Co., Buffalo, N. Y.
Herrick, A. B., Herrick & Burke, New York.
Herrick, Chas. H., W. S. Hill Electric Co., Boston.
Holmes, W. E., Newton and Watertown Gas Light Co., Newton, Mass.
Holtzer C. W., Holtzer-Cabot Electric Co., Boston.
Hine, Henry, Stanley Electric Manufacturing Co., Pittsfield, Mass.
Hotchkiss, Electrical Engineering and Supply Co., Syracuse, N. Y.
Hinds, P. A., Detroit, Mich.
Jones, A. J., Edison Illuminating Co., New Brunswick, N. J.
Johnston, W. J., *Electrical World*, New York.
Kimball, F. M., General Electric Co., Boston.
Kelly, John F., Stanley Electric Manufacturing Co., Pittsfield, Mass.
Kittle, E. B., Pettingell-Andrews Co., Boston.
Lindsale, S., Essex County Electrical Co., Essex, N. J.
Little, E. W., Interior Conduit and Insulation Co., New York.
Leonard, H. Ward, Electrical Engineer, New York.
Learned, C. A., Hudson County Electric Co., Jersey City, N. J.
McIntire, C. H., The C. McIntire Co., Newark, N. J.
Martin, A. J., Complete Electric Construction Company, New York.
Martin, T. C., *Electrical Engineer*, New York.
Mackie, C. P., Electric Selector and Signal Co., New York.
Mackay, W. H., Imperial Electric Lamp Co., New York.
MacConnell, W. J., American Electric Manufacturing Co., St. Louis.
Marks, L. B., Marks-Ayer Electric Co., New York.
Marshall, Norman, Andover Electric Light Co., Andover, Mass.
Millet, C. W., Dolgeville Electric Light and Power Co., Dolgeville, N. Y.
McLaren, P. M., Abendroth & Root Manufacturing Co., New York.
McQuaide, J. P., National Conduit Manufacturing Co., New York.
Nunn, P. N., San Miguel Consolidated Gold Mining Co., Telluride, Colo.
Newton, C. E., Jewell Belting Co., Hartford, Conn.
Osborn, W. F., *Western Electrician*, New York.
Perry, N. W., *Electricity*, New York.
Phipps, E. H., Connecticut Pipe Manufacturing Co., New Haven, Conn.
Peck, E. F., Citizens' Electric Illuminating Co., Brooklyn, N. Y.
Pentz, J. A., Electrician, Philadelphia.
Phelps, G. M., *Electrical Engineer*, New York.
Purinton, A. J., Stamford Gas and Electric Co., Stamford, Conn.
Redman, G. A., Rochester Gas and Electric Company, Rochester, N. Y.
Renahan, J. J., specialties, New Britain, Conn.
Sachs, J., Electrical Engineer, New York.
Seely, J. A., Complete Electric Construction Company, New York.
Stieringer, L., Electrical Engineer, New York.
Shain, C. D., Manufacturers' Agent, New York.
Shaw, A. C., *Electrical Engineer*, Boston.
Smith, J. Brodie, Manchester Electric Light Co., Manchester, N. H.
Smith, H. J., Edison Electric Illuminating Co., New York.
Sweetland, H. M., *Power*, New York.
Toiles, C. L., Jewell Belting Co., Hartford, Conn.
Thomson, Elihu, Lynn, Mass.
Wood, E. E., *Electrical Industries*, New York.
Wheeler, S. Bowman, Morris, Tasker & Co., Philadelphia, Pa.
Wintner, St. Louis, Brooklyn Electric Manufacturing Co., Brooklyn, N. Y.
Wiley, G. L., Standard Underground Cable Co., New York.
Walter, H. H., American Carbon Co., Noblesville, Ind.
Welsh, J. W., N. Y. C. & H. R. R. R., New York.

LADIES.

Mrs. M. J. Francisco, Mrs. C. O. Baker, Jr., Mrs. G. A. Redman, Mrs. C. H. McIntire, Mrs. H. J. Smith, Mrs. F. S. De Ronde, Mrs. C. W. Millet, Mrs. W. J. Johnston.

On the Chicago Train.

B. E. Sunny, General Electric Co., Chicago.
C. H. Wilmerding, Chicago Edison Co., Chicago.
M. A. Sullivan, Charles A. Schieren & Co., Chicago.
A. M. Searles, Diamond Electric Co., Peoria, Ill.
M. A. Beal, Forest City Electric Light and Power Co., Rockford, Ill.
W. H. McKinlock, Metropolitan Electric Co., Chicago.
C. E. Gregory, Charles E. Gregory Co., Chicago.
J. B. Wallace and William S. Hine, Wallace Electric Co., Chicago.
S. F. B. Morse, S. F. B. Morse & Co., Chicago.
George S. Searing, Hart & Hegeman Manufacturing Co., Chicago.
F. S. Terry, Sunbeam Lamp Manufacturing Co., Chicago.
J. A. Colby, and Mrs J. A. Colby, Des Moines Illuminating Co., Des Moines, Iowa.
Charles G. Burton, Central Electric Co., Chicago.
C. L. Edgar, Edison Illuminating Co., Boston.
S. G. Coleman, Badger Illuminating Co., Milwaukee, Wis.
J. C. Shainwald, Standard Paint Co. Chicago.
R. J. Randolph, Excelsior Electric Co., Chicago.
C. B. Fairchild, Street Railway Journal, New York.
M. B. Austin, Safety Wire and Cable Co., Chicago.
E. H. Fox, Phœnix Glass Co., Chicago.
Carl K. McFadden, Nutting Electric Co., Chicago.
George Cutter, Chicago.
H. H. Cutler and Mr. Conover, Cutler-Hammer Manufacturing Co., Chicago.
J. A. Roebling's Sons Co., Chicago.
Prof. W. M. Stine, Armour Institute, Chicago.
W. F. Collins, F. L. Perry and W. E. Reilly, *Western Electrician*, Chicago.
M. J. Sullivan, *Electrical World*, and Mrs. M. J. Sullivan, Chicago.
H. M. Angle, Chicago Cross-Arm Co., Chicago.
Carl Kammeyer, *Electrical Engineer*, Chicago.
E. L. Powers, Electrical Industries, Chicago.
E. Nashold, Nashold Cleat Co., Chicago.
Charles F. Foster, Chicago.
Thomas G. Grier, Bryant Electric Co., Chicago.
M. M. Wood, Wallace Electrical Co., Chicago.
F. E. Donohoe, American Electrical Works, Chicago.
Charles S. Marshall, Chicago Cross-Arm Co., Chicago.
J. W. Wolff, New York Insulated Wire Co., Chicago.
W. A. Remington, Electrical Industries, Chicago.
G. A. Hurd, Crane Elevator Co., Chicago.
W. J. Green, Cedar Rapids, Iowa
J. H. McGill, Peru Carbon Co., Chicago.
William M. Case, Hoopeston, Ill.
Hugo Benedix, the Boudreaux Dynamo Brush Co., Chicago.
W. B. McDonald, Calumet Gas Co., Chicago.
H. F. Tate, National Conduit Manufacturing Co., Chicago.
Charles E. Wilson, Ft. Wayne Electric Corporation, Chicago.

At Toledo the Chicago delegation was joined by several Detroit gentlemen, whose names follow:

W. H. Fitzgerald, Detroit Electric Light and Power Co., Detroit.
George E. Fisher, Commercial Electric Company, Detroit.
J. F. Cummings, Cummings & Engelman Conduit Co., Detroit.
W. H. Yawkey, Cummings & Engelman Conduit Co., Detroit.
J. E. Lockwood, Michigan Electric Company, Detroit.
Mr. Livesey, General Electric Co., Detroit.
A. Chase, Detroit.

From Other Points.

Elmer P. Morris, Indianapolis.
Alex. J. Wurts, Pittsburgh.
Henry D. Shute, Pittsburgh.
Frederic Nicholls, Toronto.
P. H. Alexander, New York.
E. G. Bernard, Troy, N. Y.
Alfred Turner, Rutland, Vt.
E. H. Abodie, St. Louis, Mo.
Geo. B. Dusenberry, Pittsburgh.
J. E. Rhetts, Salem, Ind.
J. Ullman, Meridian Gas Light Co., Birmingham, Ala.
J. H. Allen, Atlanta, Ga.
J. E. Lockwood, Detroit.
Irwin Shepard, Winona, Minn.
Aaron Gore, Denver.
E. P. Roberts, Cleveland.
E. H. Heinrichs, Westinghouse Electric and Manufacturing Co., Pittsburgh.
Thos. Spencer, Philadelphia.
Geo. T. Manson, New York.
W. L. Candee, New York.
F. W. Royce, Washington.
Wetson G. Howell, Harrison, N. J.
W. T. Harris, Washington.
C. W. Bucholz, New York.
J. McGhie, General Electric Co., New York.
L. W. Washington, Pittsburgh.
J. D. A. Babcock, Cuyahoga Falls.
H. C. Wirt, Schenectady, N. Y.
C. E. Harthan, Lynn.
H. H. Brooks, Boston.
Jas. S. Wilson, Boston.
Albert Scheible, Chicago.
J. H. Shay, Chicago.
P. B. Chaney, electric engineering, architecture and building, Chicago.
Fred. De Land, *Electric Engineering*, Chicago.
Romaine Mace, New York.
T. McCoubray, New York.
Geo. F. Porter, secretary National Electric Light Association, New York.
Miss Harriet Billings, New York.
W. C. Bendow, Cincinnati.
W. Greenwood, Schenectady.
H. P. Schuyler, Schenectady.
L. S. Nold, Schenectady.
J. H. Allen, Atlanta.

From All Points.

The following are names of convention visitors not included in other lists presented in this issue:

J. H. Burghardt, Page Belting Co., Boston, Mass.
W. L. Candee and Geo. T. Manson, Okonite Co., New York.
Fred W. Royce, Washington, D. C.
T. E. Crossman, Stenographer, New York.
Ike Ullman, Meridian Gas Co., Birmingham, Ala.
P. C. Ackerman, American Electrical Works, New York.
L. W. Washington and John S. Crider, Washington Carbon Co., Pittsburgh, Pa.
Frederic Nicholls, Toronto Incandescent Electric Light Co., Toronto, Canada.
H. A. Douglass and Albert Scheible, Chicago, Ill.
Wilson S. Howell, Edison Lamp Works, Harrison, N. J.
A. H. Hough, S. H. Rogers and W. S. Rogers, Brush Electric Co., Cleveland, O.
J. D. McIntyre, Electric Engineering and Supply Co., and Mrs. J. D. McIntyre, Syracuse, N. Y.
Romaine Mace, Interior Conduit and Insulation Co., New York.
J. McGhie, General Electric Co., New York.
James Kennedy, Kennedy & Du Perow, Washington, D. C.
E. H. Abadie, Wagner Electric Manufacturing Co., St. Louis, Mo.
Alexander Jay Wurts, Westinghouse Electric and Manufacturing Co., Pittsburgh, Pa.
P. H. Alexander and A. L. Searles, Electric Selector and Signal Co., New York.
E. G. Bernard, E. G. Bernard Co., Troy, N. Y.
H. P. Schuyler, General Electric Co., Schenectady, N. Y.
Jas. S. Wilson and H. H. Brooks, American Circular Loom Co., Boston, Mass.
C. J. Wells, Electric Appliance Co., Chicago, Ill.
L. W. Greene, city electrician, Hillsdale, Ia.
J Gwynn, Steubenville Gas and Electric Co., Steubenville, O.
W. C. Bryant, Bryant Electric Co., Bridgeport, Conn.
Geo. R. Lean, Buckeye Electric Co., Cleveland, O.
J. J. Burleigh, Camden Lighting and Heating Co., Camden, N. J.
W. W. Low, Electric Appliance Co., Chicago, Ill.
C. A. Bragg, Westinghouse Electric and Manufacturing Co., Mrs. C. A. Bragg and Miss Bragg, Philadelphia, Pa.
Webb C. Hayes and H. E. Hackenberg, the National Carbon Co., Cleveland, O.
John J. Jennings, Wilkinsburg Electric Co., Wilkinsburg, Pa.
Wm. Weierbach, Standard Paint Co., New York.
Jerome Penn, Washington Gas and Electric Co., Washington, D. C.
E. P. Young, Sewickley Electric Co., and Mrs. E. P. Young, Sewickley, Pa.
John I. Beggs, the Cincinnati Edison Electric Co., Cincinnati, O.
C. D. Jenney, Jenney Electric Motor Co., Indianapolis, Ind.
A. W. Field, Columbus Edison Electric Light Co., Columbus, O.
J. A. Cabot, city electrician, Cincinnati, O.
Richard Young, Faraday Heat, Lighting and Power Co., Morton, Pa.
Geo. H. R. Hayes, the Brush Electric Co., Cleveland, O.
Henry E. Cooke, Home Security Co., Cleveland, O.
J. E. Rhetts, Salem Electric Light and Power Co., Salem, Ind.
Thomas Cooper, Fort Wayne Electric Corporation, Columbus, O.
E. H. Heinrichs, Westinghouse Electric and Manufacturing Co., Pittsburgh Pa.
Geo. R. Stetson and Chas. R. Price, New Bedford Gas and Edison Light Co., New Bedford, Mass.
H. L. Shippy, John A. Roebling's Sons' Co., New York.
A. B. Conover, John A. Roebling's Sons' Co., Chicago, Ill.
E. O. Waymire, Dayton Fan and Motor Co., Dayton, O.
O. D. Chase, Commercial Electric Engineering Co., Detroit, Mich.
T. A. Boardman, Jr., and E. L. Nash, Swan Lamp Manufacturing Co., Cleveland, O.
C. L. Hills, Columbia Incandescent Lamp Co., New York.
J. R. Frentiss, the Brush Electric Co., Cleveland, O.
T. Beran, General Electric Co., New York.
C. L. Gibson, Cleveland, O.
W. D. Packard, New York and Ohio Co., and Mrs. W. D. Packard, Warren, O.
J. F. Outwater, Edison Electric Illuminating Co., Brooklyn, N. Y.
R. N. Baylis, the Walker Manufacturing Co., Cleveland, O.
H. McL. Harding, the Walker Manufacturing Co., New York.
Wm. M. Broeck, Edison Electric Illuminating Co., Paterson, N. J.
Edward B. Hatch, H. W. Johns Manufacturing Co., Hartford, Conn.
Jas. Partridge, Partridge Carbon Co., Sandusky, O.
H. P. Hill, Hill Clutch Co., Cleveland, O.
C. F. Munder, Bryan-Marsh Co., New York.
A. H. Mustard, Washington Carbon Co., Pittsburgh, Pa.
J. T. Cowling, Powelton Electric Co., Philadelphia, Pa.
N. S. Possons, Cleveland, O.
A. H. Jones, Suburban Electric Co., Philadelphia, Pa.
G. A. Wilberg, Ft. Wayne Electric Corporation, Philadelphia, Pa.
S. O. Richardson, Jr., Libbey Glass Co., Toledo, O.
B. P. Holmes, Youngstown Electric Light Co., Youngstown, O.
A. Pabst, Mahoning Electric Light Co., Youngstown, O.
W. S. McLeod and John R. Galloway, Washington, D. C.
Sam A. Freshney, Muskegon Electric Light and Power Co., Muskegon, Mich.
C. C. Gartland, Buffalo General Electric Co., Buffalo, N. Y.
Jas. S. Belote, Electric Company of Virginia, Norfolk, Va.
A. D. Donovan, Brush Electric Co., Cleveland, O.
L. B. Cruikshank, the Hazelton Boiler Co., New York.
H. S. Conner, St. Paul.
T. E. Adams, Brush Electric Co., Cleveland.
W. R. Caulkins, Commercial Electric Co., Cleveland, O.
J. C. Hadley, Pana Electric Light and Street Railway Co., Pana, Ill.
Geo. M. Hoag, city electrician, Cleveland, O.
J. F. Gerleman, American Electrical Manufacturing Co., St. Louis, Mo.
E. H. McKnight, Electric Light Co., Middletown, O.
H. L. Brintnall, the Swift Electric Light Co., Saginaw, Mich.
Luke Lilley, underwriters' electrician, Cincinnati, Ohio.
F. H. Welscher, Citizens' Electric Co., Battle Creek, Mich.
C. B. Humphrey, Heine Safety Boiler Co., Pittsburgh, Pa.
Peter Wright, United Gas Improvement Co., Philadelphia, Pa.
Forrest E. Barker, Massachusetts Commission, Boston, Mass.
Samuel E. Cox, The Swan Lamp Manufacturing Co., Cleveland, O.
Albert Pabst, Youngstown Electric Light Co., Youngstown, O.
Geo. W. Cleveland, electric expert, Cleveland, O.
J. Alward Seymour, McIntosh, Seymour & Co., Auburn, N. Y.
F. H. McGraw, Pa. Ind. Reformatory, Huntingdon, Pa.
Wm. C. Thayer, Cleveland, O.
F. Houghton, C. & C. Electric Co., Cleveland, O.
C. T. Richmond, Thomson-Houston Carbon Co., Fremont, O.
S. T. Carnes, Memphis Light and Power Co., Memphis, Tenn.
E. E. Bearn, Barberton Electric Co., Barberton, O.
C. P. White, Evansville, Ind.
F. S. Smith, Calvert Townley, Westinghouse Electric and Manufacturing Co., Pittsburgh, Pa.
H. T. Edgar, Georgia Electric Light Co., Atlanta, Ga.
Edwin J. Houston, A. E. Kennelly, Houston-Kennelly, Philadelphia, Pa.
Jas. G. Rossman, Oscar C. Turner, Georgia Electric Light Co., Atlanta, Ga.
Jas. G. Muirhead, Batesville Electric Co., Batesville, Ind.
H. A. Craigin, Westinghouse Electric and Manufacturing Co., New York.
J. M. Uptegraff, Sswickley Electric Co., Allegheny, Pa.
D. L. Davis, Salem Electric Light and Power Co., Salem, O.
F. R. Swaney, Ceramic City Light Co., East Liverpool, O.
Walter E. Harrington, the Cutter Electric and Manufacturing Co., Philadelphia, Pa.
B. J. Lamme, H. P. Davis, Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.
W. H. Gardener, Pittsfield Electric Co., Pittsfield, Mass.
Chas. F. Scott, Westinghouse Electric and Manufacturing Co., Pittsburgh, Pa.
J. C. Hobart, Triumph Electric Co., Cincinnati, O.
E. E. Wade, El Paso Electric Co., Colorado Springs, Colo.
H. T. Paiste, H. T. Paiste Co., Philadelphia, Pa.
Chas. E. Rodman, Globe Carbon Co., Ravenna, O.
Edward Wilkins, Partrick & Carter Co., Philadelphia, Pa.
W. T. Hunt, *Electrical Age*, New York.
Edward A. Colby, Baker & Co., Newark, N. J.
Cecil P. Poole, New York.
J. W. Taylor, Peterboro, Can.
J. H. Kammerer, the Royal Electric Co., Montreal, Can.
W. Worth Bean, St. Joseph & Benton Harbor Electric Railway and Light Co., St. Joseph, Mich.
A. H. Manwaring, Brush Electric Light Co. and Mrs. A. H. Manwaring, Philadelphia, Pa.
C. W. Phipps, Cleveland, O.
John K. Martin, Jas. J. Murray & Co., Philadelphia, Pa.
W. H. Atkins, Edison Electric Illuminating Co., Boston, Mass.
Samuel Barnes, Sweet Electric Manufacturing Co., Grand Rapids, Mich.
T. F. Flanagan, Portsmouth Gas Light Co., Portsmouth, N. H.
D. F. Urquhart, Thomson-Houston Carbon Co., Boston, Mass.
G. H. Blaxter, Allegheny County Light Co., Pittsburgh, Pa.
Geo. M. Phelps, *The Electrical Engineer*, New York.
A. K. Thresher, Dayton, O.
Paul T. Brady, Westinghouse Electric and Manufacturing Co., Syracuse, N. Y.
H. W. Hudson, Brush Electric Co., Cleveland, O.
Samuel A. Chase, Western Electric Co., New York.
Edward C. Toll, Sterling Cycle Works, Chicago, Ill.
Fred. DeLand, *Electrical Engineering*, Chicago, Ill.
C. A. Gates, Russell Engine Co., Massillon, O.
E. J. Wehrly, Arbuckle, Ryan & Co., Toledo, O.
Emil G. Schmidt, Sandusky Electric Light Co., Sandusky, O.
Thos. J. Creaghead, The Creaghead Engineering Co., Cincinnati, O.
Thos. Spencer and Frank S. Marr, Helios Electric Co., Philadelphia, Pa.
Geo. H. Lewars, Westinghouse Electric and Manufacturing Co., Pittsburg, Pa.
E. A. Armstrong, Camden Lighting and Heating Co., Camden, N. J.
Frank J. J. Sloat, Sandusky, O.
Chas. F. Lewis, Chas. J. Dailey and M. D. Shay, Cleveland, O.
Wm. L. Morris, J. F. Randall & Co., Cleveland, O.
C. A. Latham, Loraine County Light and Power Co., Elyria, O.
Henry B. Cutter, Cutter Electric and Manufacturing Co., and Mrs. Henry B. Cutter, Philadelphia, Pa.
S. N. Root, Partridge Carbon Co., Sandusky, O.
C. A. Roberts, Electric Belt Co., Sandusky, O.
Thos. O'Dea, Edison Electric Light and Power Co., Erie, Pa.
C. Casper, Springfield, O.
J. L. Hinds, C. D. Riggs and H. C. Hodgkins, Electrical Engineering and Supply Co., Syracuse, N. Y.
Bailey S. Whipple, the Buckeye Electric Co., Cleveland, O.
S. H. Prentiss, Manhattan General Construction Co., New York.
A. H. Melton, The Brush Electric Co., Cleveland, O.
C. D. Smith, National Carbon Co., Cleveland, O.
P. B. Chaney, Central Electric Co., Chicago, Ill.
Jas. Ritchie, Manufacturers' Electric Co., Philadelphia, Pa.
E. W. Mix, Cie. Française Thomson-Houston, Paris, Philadelphia, Pa.
Geo. Lounitz, Jr., Savings and Trust Co., Cleveland, O.
C. J. H. Woodbury, American Bell Telephone Co., Boston, Mass.
A. T. Moore, Buffalo, N. Y.
M. Murphy, Second Avenue Railroad Co., Pittsburgh, Pa.
W. J. Burns, West Side Railroad Co., Pittsburgh, Pa.
Walter Marlatt, Galion, O.
Wm. C. Hedges, Mansfield, O.
L. McDonald, Duquesne Electric Co., Duquesne, Pa.
S. A. Johns, Cleveland Electric Illuminating Co., Cleveland, O.
B. F. Thomas, Ohio State University, Columbus, O.
F. E. Jackson, Aylesworth & Jackson, Orange, N. J.
F. F. Ainsworth, A. Lovell & Co., Chicago, Ill.
Homer Laughlin, Wellsville Electric Light Co., Wellsville, O.
S. Marsh Yancey and Stuart M. Wise, Manhattan General Consolidated Co., New York.
Charles F. Ernst, Standard Carbon Co., Cleveland, O.
W. J. Hanley, General Electric Co., Cincinnati, O.
Louis Bell, General Electric Co, Chicago, Ill.
R. S. Stearnes, Cincinnati General Electric Co.
S. H. Short, Walker Mfg. Co., Cleveland, O.
H. C. Wirt, Schenectady, N. Y.
John L. Gans, C. N. D. L. St. Ry., Connellsville, Pa.
Jno. B. Whalen, J. B. Whalen & Co., W. P. Wire, Sycamore, Ill.
H. M. Lyman, Canton Electric Light and Power Co., Canton, O.
John A. Erner, Bissel & Dodge, Toledo, O.
J. E. Pyle, Westchester, Pa.
F. A. Williams, Safety Insulated Wire and Cable Co., New York.
Joseph W. Marsh, Henry W. Fisher, Standard Underground Cable Co., Pittsburgh, Pa.
Edward Lasell, Chicago, Ill.
John Langton, Toronto, Canada.
E. T. Wilkinson, Philadelphia, Pa.
H. B. Brooks, Piqua Electric Co., Piqua, O.
J. C. Perry and J. Caven, Indianapolis Light and Power Co., Indianapolis, Ind.
Jas. Boyce, Heat, Light and Power Co., Muncie, Ind.
P. Dubold and J. J. Davis, Orr & Howe Electric Co., Pittsburgh, Pa.
H. G. Field, Field & Hinchman, electrical engineers, Detroit, Mich.
P. A. Hinds, Peninsula Electric Light Co., Detroit, Mich.
Charles S. Bradley, New York.
W. D. Crompton, Pittsburgh, Pa.
Edmund Dickey and G. A. Gessner, The American Carbon Co., Dayton, O.
L. D. Tandy, General Electric Co., Schenectady, N. Y.
Jas. R. Dee, Philadelphia, Pa.
T. Carpenter Smith, Keystone Lighting and Power Co., Philadelphia, Pa.
Allyn B. Walton, "W. C. Thayer," Cleveland, O.
John Mustard, Wagner Electric Manufacturing Co., Philadelphia, Pa.
E. L. Nash, Swan Lamp Manufacturing Co., Cleveland, O.
C. B. Fairchild, *Street Railway Journal*, New York.
E. M. Sanderson, Westinghouse Electric and Manufacturing Co., Boston, Mass.
W. D. Kearfott, H. M. Farrand and A. B. Calhoun, Cleveland, O.
Clarence E. Stump, *Street Railway Gazette*, New York.
H. T. Pratt, Washburn & Moen Manufacturing Co., Worcester, Mass.
E. J. Bagnall, St. Louis, Mo.
J. B. Taltavall, *Electrical Age*, New York.
B. G. Foster, Cleveland, O.
R. B. Smith, Belknap Motor Co., Philadelphia, Pa.
W. A. Foote, Jackson Electric Light Co., Jackson, Mich.
J. B. Foote, Battle Creek Electric Light Co., Battle Creek, Mich.
Louis Nahm, American Electrical Manufacturing Co., St. Louis, Mo.
D. T. Flick, New Castle Electric Co., New Castle, Pa.
C. R. Van Trump, Wilmington City Electric Co. Wilmington, Del.
Thomas McCoubray, Tucker Electrical Construction Co., New York.
Jas. A. Dee, Peninsula Electric Light and Power Co., Houghton, Mich.
L. H. Thullen and J. C. Thullen, Leetonia, O.
Mr. and Mrs. Geo. M. Myers, Kansas City, Mo.
T. P. McDonough and W. C. Baker, Cleveland, O.
G. W. Conover, Chicago, Ill.
D. N. McBrier, Ball Engine Co., Erie, Pa.
J. W. Godfrey, Habirshaw Wire, New York.
Geo. B. Dusinberre, Westinghouse Electric and Manufacturing Co., Pittsburgh, Pa.
J. R. Lovejoy, General Electric Co., Schenectady, N. Y.
C. F. Wright and C. F. Eberhard, Eberhard & Wright, Cleveland, O.
F. Wayland Brown, Osborne Manufacturing Co., Cleveland, O.
M. M. Hayden, National Carbon Co., Cleveland, O.
J. Edgar Gould, Philadelphia, Pa.
Col. E. L. Babcock and C. A. Babcock, Falls Rivet and Machine Company, Cuyahoga Falls, O.
H. C. Harthan, General Electric Company, Schenectady, N. Y.
A. V. Doe, Philadelphia, Pa. (Jute Yarns.)
L. W. Greene, Brooklyn Electric Light Company, Brooklyn, Mich.
C. S. Knight, Ft. Wayne Electric Corporation, Ft. Wayne, Ind.

American Institute of Electrical Engineers.

The ninety-fourth meeting of the institute will be held at 12 West Thirty-first street, New York city, on Wednesday, February 27, at 8 P. M.

A paper will be presented by Mr. H. Ward Leonard, of New York city, entitled, "Notes on Recent Electrical Engineering Developments in France and England."

Among the topics treated will be, Rotary Transformers. The Parsons Steam Turbine, The Laval Steam Turbine, English and French Central Stations, The Heilman Locomotive, etc.

A meeting of western members will be held the same evening, Wednesday, February 27, at Armour Institute, Thirty-third street and Armour avenue, Chicago, where the above paper will also be read and discussed. Members of other engineering societies are especially invited to attend.

The February issue of the transactions, containing the above paper, will be distributed in advance of the meeting.

New England Engineering Company.

We have received with the compliments of this company a very attractive and satisfactory self-renewing lead pencil, and beg to tender our thanks to the New England Engineering Company for its appreciation of the needs of an editor.

ELECTRIC RAILWAY NOTES.

Officers of electric railway companies are requested to send promptly to the ELECTRICAL REVIEW *notices of meetings, election of officers, declarations of dividends, financial reports and all items of interest in connection with the financial and practical operation of their roads.*

At Newburg, N. Y., the car sheds of the Newburg Electric Street Railway, with nine cars, burned; loss, $5,000.

All telegraph operators on the Wabash railroad will hereafter be required to give a bond of $500 for the faithful performance of their duties.

Detroit hopes to have real rapid transit on all its lines by October 1. Tom. L. Johnson is now the president of the Citizens' Street Railway Company.

The Calumet Electric Street Railway Company, of Chicago, has filed a trust deed to the Equitable Trust Company to secure $3,000,000 gold construction bonds.

A contract has been awarded to John H. Pacher, of Plattsburg, Md., for the building and equipping of an electric light plant in that city. It is understood the plant is to be in operation by May 1.

H. C. Cushing, Jr., Inspector of the Boston Board of Fire Underwriters, has just published a third edition of his book on "Standard Wiring." It has been greatly enlarged and revised, and is meeting with large sale throughout the country.

Side-door electric cars are to be run by the Detroit Railway Company. The cars are 24 feet long over the body, with vestibuled front platform and open rear platform, and a sliding door in the middle of one side, along which side there is a passageway, the transverse seats being shorter than the width of the car. Only one side-door is required, as the car will turn on loops at the ends of the line.

Reports come from Hartford of the serious injury of two men through the toppling over of one of the tall overhanging platform wagons from which they were making overhead repairs. In this connection, we hear from the New England Engineering Company, of Waterbury, Conn., that their tower wagon is not in the habit of spilling its occupants in this way. It can be depended upon to stand upright, and is gaining favor rapidly among street railway companies.

About 700 cars in all were disabled during the Brooklyn trolley strike. The strike has been declared off. Another defeat for misled toilers. Attorney-General Hancock has denied the applicaton for permission to begin an action to annul the charter of the Brooklyn Heights Railroad Company, and also the application asking him to bring an action to remove from office the president of that company and the president of the Atlantic Avenue Railroad Company, because of violations of the ten-hour law.

Electric Light Convention

NEWSY PARAGRAPHS ABOUT THE VISITORS AND EXHIBITS.

INCIDENTS OBSERVED AND CHRONICLED BY OUR BRIGHT YOUNG MEN. —A VERY LIVELY SCENE AT ALL HOURS.

Convention Notes.

Tuesday morning, the opening day of the eighteenth convention of the National Electric Light Association, saw the city of Cleveland thronged with visitors, and in and about the Hollenden, convention headquarters, the greatest activity prevailed. The special bringing the New York delegation arrived Monday evening, or rather Tuesday morning about one o'clock, and, despite the hour, quite a number of wide-awake, early arrivals were on hand to welcome them.

The Chicago contingent got in about breakfast time on Tuesday, and the spacious corridors of the hotel for some hours thereafter resounded with cheery greetings. The crowd was simply immense, but the facilities for handling them were, on the whole, excellent.

The Hollenden is admirably arranged for convention purposes, the handsome series of parlors and reception rooms on the first floor being utilized as headquarters by various concerns for the entertainment of their visitors.

The ELECTRICAL REVIEW received its friends, and they were many, in what is ordinarily used as the ladies' reception room on the right of the main corridor, directly at the head of the grand staircase. The interests of the REVIEW were looked after by Stephen L. Coles, associate editor, and H. G. Tuckerman, manager Boston branch office.

The headquarters of the *Electrical Engineer* were immediately opposite, and were presided over by Geo. M. Phelps, T. C. Martin, A. C. Shaw and C. Cammeyer.

Electricity was next in order on the right, and here were to be found B. E. Greene and N. W. Perry.

Secretary George F. Porter, of the National Electric Light Association, had his location at the intersection of the two main corridors, where he was easily accessible from all sides, and it is needless to say he and his corps of assistants were kept fully occupied at all times. Every provision had been made by him for the convenience of the delegates, and as usual he was in himself a valuable mine of information.

Next adjoining were the spacious quarters of the Brush Electric Company and the Swan Lamp Company, of Cleveland. The Brush company did not undertake to make any extensive exhibit of their well-known apparatus, merely displaying a handsome line of Brush arc and Swan incandescent lamps. On a table in the center of their room, however, was a little machine which attracted a great deal of attention. This was the first dynamo manufactured by the Brush company in 1876, and sold to a manufacturing company of Baltimore the following year. In comparison with the machines of the present day this little dynamo is indeed a pocket edition, its dimensions being only two feet in length by one in width, and about the same in height. It was in constant use until 1889, when it was laid aside to make room for one of a larger type. A testimonial letter from the company was exhibited in connection with the machine, speaking in the highest terms of its efficiency and other good qualities.

Among the numerous gentlemen connected with the Brush company, who were very much in evidence, were: S. M. Hamill, general manager; L. H. Rogers, assistant general manager; A. H. Hough, secretary; A. D. Dorman, manager sales department; Col. W. S. Rogers, I. R. Prentiss, C. W. Phipps, superintendent; Charles M. Black, assistant superintendent; and T. E. Adams. The Swan Lamp Company was represented by S. E. Cox, secretary.

The Weston Electrical Instrument Company was represented by Charles D. Shain, of New York, and Richard O. Heinrich, of Newark, N. J. The feature of their exhibit was a mammoth central station ammeter, having a capacity of 80,000 amperes. This is a standard instrument and the largest ever turned out.

The *Western Electrician* was sumptuously housed in parlor 130, as countless signs in every available spot in the hotel proclaim, and their representatives. W. F. Collins, F. L. Perry and W. E. Keiley, of Chicago, and W. F. Osborne, of New York, were very much in evidence.

The Buckeye Electric Company, of Cleveland, made one of the handsomest lamp exhibits seen in a long time, their parlor being fitted up with special racks, extending from floor to ceiling, and showing tier after tier of lamps of all sizes, shapes and colors. There were over 7,000 lamps displayed, and the effect was simply dazzling. These lamps ranged from eight to 100 candle-power inclusive, and from 45 to 130 volts. An immense number of special designs for decorative work were shown, among the newest of which was an opal candle lamp, which, when illuminated, was a very realistic imitation of the natural wax. A very attractive feature was an immense stag's head, the tips of the 12 spreading antlers of which were mounted with little decorative 10 candle-power lamps. The effect of these when illuminated may be imagined. The company was represented by C. H. Rockwell, J. Potter, George R. Lean, Bailey Whipple, Arnold Spiller and Jack Massey.

The Fort Wayne Electric Corporation was represented by the popular C. S. Knight, vice-president; J. J. Wood, chief electrician; G. A. Wilbur, of Philadelphia; S. A. Douglass, of New York, and Thomas Cooper, of Columbus, Ohio. Very handsome little souvenir paper weights in the shape of miniature transformers were distributed.

The headquarters of the American Circular Loom Company, of Boston, under the genial influences of H. H. Brooks, general manager, and J. S. Wilson, superintendent, was one of the popular gathering places of the fraternity. The above named gentlemen are past masters in the art of entertaining, and they were afforded full scope for their talents in this direction.

The exhibit of flexible conduit was very complete and tastefully arranged and practical demonstrations were afforded of the utility of these goods for all kinds of interior work. A full line of tubing was displayed, ranging from one-quarter inch to one and one-quarter inch, and made up in various forms. A very noticeable feature of this room was that pilgrims were never allowed to go thirsty from the door.

The General Electric Company were quartered in the banquet hall, and their exhibit here consisted of a line of incandescent lamps, noticeable among which were their 100-volt night lamps, 20, 30 and 50 candle-power oval filaments, and 10 and 12½ 3-watt lamps. Their principal exhibit was at the new station of the Cleveland Illuminating Company, where a fine line of apparatus, including the new Monocyclic generator, is in operation. As usual the General Electric Company was represented handsomely, among those present being Professor Elihu Thomson, J. R. Lovejoy, T. Beran, F. M. Kimball, W. F. Hays, John McGhie, H. C. Wirt, W. F. Bostwick, W. S. Howell, L. F. Tandy, H. E. Harthan and W. C. Benbow.

The Chicago Cross-Arm Company were represented by H. M. Angle and Charles S. Marshall. This concern is also the western agent for the Ericsson Telephone Company, of Stockholm, Sweden. A line of beautiful instruments, both for long and short distance service, was displayed.

The Standard Paint Company, of New York, was ably and forcibly in evidence in the persons of Messrs. J. C. Shainwald, of the company's Chicago office, William Weierbach, of the New York office, and Frank S. De Ronde, general sales manager of the company. The famous "P. & B." cigars, as well as samples of "P. & B." paint, tape and other products were in constant demand. The company made a hit previous to the meeting by supplying Secretary Porter with a quantity of very tasteful grass card cases, in which the tickets and seat checks purchased by the delegates were enclosed.

The John A. Roebling's Sons' Company, of Trenton, N. J., was represented by Messrs. Shippy, of New York, Conover, of Chicago, and Bowman, of Cleveland.

The well-known platinum house of Baker & Company, Newark, N. J., was represented by Messrs. C. O. Baker, Jr., and E. A. Colby, both of whom have an extensive acquaintance in the electric lighting field.

The National Carbon Company, of Cleveland, was represented by Messrs. B. F. Miles and H. E. Hachenberg. The National product is well-known among electric light men.

The Wallace Electric Company, of Chicago, placed their interests in the capable hands of Messrs. J. B. Wallace and W. S. Hine, who entertained their friends in their well-known genial manner.

The Stanley Electric Manufacturing Company, of Pittsfield, Mass., had the following gentlemen of ability and experience as their representatives: Messrs. Henry Hine, J. F. Kelly and Mr. Chesley.

Morris, Tasker & Company, of Philadelphia, manufacturers of a well-known type of tubular iron railway and electric light poles, were represented by Mr. S. B. Wheeler.

Mr. T. F. Morrin, inventor of the well-known "climax" steam generator made by the Clonbrock Steam Boiler Works, of Brooklyn, N. Y., was present at the convention and made many new friends. The installation of "climax" boilers in the station of the Cleveland Illuminating Company was visited and much admired by many of the delegates.

The American Carbon Company, of Dayton, Ohio, and Noblesville, Ind., was ably represented by Secretary Edmund Dickey and Mr. Water. The Western agency for the American carbons has been taken by the Metropolitan Electric Company, of Chicago.

Mr. Gerald W. Hart represented the Hart & Hegeman Manufacturing Company, of Hartford, Conn., whose line of switches is so well known.

The Safety Insulated Wire and Cable Company, of New York, placed its interests in the hands of its Western representative, Mr. M. B. Austin, who distributed a novel watch-guard and a very cute puzzle.

Little books of street car passes, good on all the street railways of Cleveland, were issued to the visitors by the Cleveland City Railway Company and the Cleveland Electric Railway Company. This courtesy was much appreciated.

The Washington Carbon Company, of Pittsburgh, was ably represented by Messrs. J. S. Humbird and J. S. Crider.

Mr. Kittle, of Boston, was strongly in evidence as the representative of the Pettingell-Andrews Company, of Boston, and the Interior Conduit and Insulation Company, of New York.

Mr. W. A. Stadelman, who is to represent in New York city the Elwell-Parker Electric Company of America, whose head offices are in Cleveland, was ubiquitous and genial as usual.

The Phœnix Glass Company, of Pittsburgh, was represented by its Western manager, Mr. E. H. Fox, who has an unusually large acquaintance with electric light men.

The Electric Storage Battery Company, of Philadelphia, had a strong champion of the chloride accumulator in Mr. Herbert Lloyd.

The Michigan Electric Company, of Detroit, exhibited a 10 kilowatt 125-volt generator, manufactured by the Detroit Electrical Works, of which they are the general selling agents. This machine is an iron-clad by-polar dynamo of latest design, having self-oiling and self-aligning journals and carbon brushes which require no trimming. It is compound wound, securing automatic regulation, and the windings and the commutators are entirely insulated from the cores by a layer of best India mica. Mr. Joseph E. Lockwood, president of the Michigan Electric Company, was on hand to look after the interests of the concern and to push the large line of other specialties for which his house are western agents. Among these are the canvas jacket flexible conduits, C. F. specialties, P. & B. goods, and others.

The Holtzer Cabot Electric Company, of Boston, exhibited a line of their alternating and direct current fan motors which were very well received. The company was represented by Mr. C. W. Holtzer and H. E. Hall.

The Interior Conduit and Insulation Company, of New York, showed samples of Lundell motors and generators, and made a handsome display of their various forms of insulated conduits armored with brass and iron, the latter being their latest production. A handsome souvenir in the shape of an illustrated pamphlet showing prominent buildings in which their system is in use was distributed. E. W. Little, manager, and Romaine Mace were the representatives.

The Electric Storage Battery Company, of Philadelphia, exhibited a mammoth chloride accumulator having a capacity of 4,000 ampere hours and a maximum output of 1,000 amperes. The company was represented by Herbert Lloyd, general manager, and J. R. Williams.

The Sterling Water Tube Boiler Company, of Chicago, made an attractive exhibit in the shape of photos, showing some of the largest installations of their boilers in leading power plants throughout the country. Mr. F. A. Scheffler, of the New York office, ably represented this enterprising company.

The Boudreaux Dynamo Brush Company, of Chicago, was ably represented by Mr. Hugo Benedix, general manager, and a line of their brushes was shown, together with a number of handsome testimonials from concerns who are using them.

These brushes combine a number of excellent qualities and are meeting with ready appreciation. Mr. Benedix goes to New York shortly for the purpose of opening an office in that city.

The Reliance Gauge Company, of Cleveland, Ohio, made an excellent showing of their large line of steam gauges and connections. They were represented by Mr. Wright and Mr. Higgins.

The Eppinger & Russell Company, of New York, exhibited a line of models of their electrical conduits in various sizes. Mr. George S. Valentine was the convention representative.

The Cleveland Electrical Manufacturing Company, of Cleveland, had on exhibition one of their American watchman time detectors and also their fire alarm system. This concern are the western agents for the Indiana Rubber and Insulated Wire Company as well, and Mr. C. J. Butler, secretary and manager of the latter company, was in attendance and distributed a neat little souvenir in the shape of a celluloid wiring calculator.

The Prentiss Clock Improvement Company, of New York, had one of their 90-day master clocks on exhibition. One of the features of these clocks is that they are mechanically wound every six hours by the main spring, which only requires attention once in 90 days. They are closely regulated and display in the lower part of the case a yearly calendar showing the month, day of the week and date. They are the invention of Mr. Henry S. Prentiss, of New York.

The Paragon Insulating Company, of Chicago, exhibited a line of their Acme Insulating Paint, and were represented by F. E. Abbott and J. H. Parker, of Boston.

Mr. E. P. Roberts, of Cleveland, assisted by W. M. Woodward, was in charge of a large number of exhibits, acting as convention representative for a number of out-of-town concerns. Mr. Roberts had a large parlor at his disposal, and the various goods under his control were attractively displayed. He was untiring in his efforts to make things pleasant for the delegates and rendered them considerable assistance. One very convenient feature, for which a number had occasion to thank him, was the installation of a long distance telephone in his quarters which the Bell company kindly donated to the use of the delegates. The service was free at all times for local business and for long distance work between the hours of 5 P. M. and 9 A. M. Among the interesting souvenirs distributed by Mr. Roberts was a pamphlet on the electrical industries of Cleveland.

The Anchor Electric Company, of Boston, showed a full line of "Iona" specialties, besides samples of acme wire, the Dow cord adjuster and the anchor cleat, which is something comparatively new. Their interests were looked after by Mr. Norman Marshall, vice-president.

Mr. H. B. Cram, of Boston, representing the Bernstein Electric Company, was a well-known figure about the hotel corridors, and was kept busy answering the salutations of his many friends.

The Westinghouse Electric and Manufacturing Company, of Pittsburgh, made a remarkably handsome exhibit of the Westinghouse stopper lamp, arranged in ornamental designs on a large bank board. This arrangement was designed to show, in addition to the good qualities of the lamps themselves, the excellent qualities of the glass which is turned out at the works of the factory. The lamps ranged from six to 32 candle-power, and included many ornamental designs. An exhibit of the standard types of Werts non-arcing metal and non-arcing railway lightning arresters was also displayed, and a model trolley line was in operation showing the action of lightning. Current for this purpose was generated from a static machine. The Westinghouse company, as usual, had a big force of representatives on hand to look after their interests. Among them were: Ernest H. Heinrichs, H. P. Davis, M. Crompton, B. Lamme, C. F. Scott, J. A. Rutherford, I. C. Hubner, A. J. Wurtz, H. D. Shute, C. Townley, F. S. Smith, R. D. Mershon, George B. Dusinberre, E. W. Sanderson, H. A. Craigin, C. A. Bragg and J. S. Tebbetts.

The Tucker Electrical Construction Company, of New York, made an interesting exhibit of their autotelephone system, showing the operation of a line of half a dozen stations. This was done by means of a 1,000-foot cable, to which our various instruments were connected. The operation of the system is extremely simple and to a large extent automatic, the placing of the receiver to the ear breaking the bell circuit and notifying the party sending in the call that it has been received. Calls were sent and received over the same cable from all the instruments and conversations carried on from one to any of the others by merely throwing the switch to the number of the station wanted. The interests of the company were looked after by Mr. Thomas McCoubray.

Among the other exhibitors were the McNeil Boiler Works, of Akron, Ohio; Henry R. Worthington, of New York; the Vulcan Company, of New York, who exhibited their new vulcan torch; the Sweet Electrical Manufacturing Company, of Grand Rapids, Mich.; the Akron Insulator and Marble Company.

An exhibit that attracted an unusual degree of interest was that of Morris & MacCurdy, of Indianapolis, Ind., whose Phœnix rubber insulating paint was submitted to the severest kind of tests with astonishing results. This insulating compound was something entirely new, and is just being introduced into the electrical field. From the results shown under the tests made before the convention there is no doubt it is one of the most valuable insulating compounds ever put on the market, and that this fact was appreciated by the electrical men present was attested by the number of orders booked while the exhibit was under way. The paint is a mineral production containing quick drying natural oils, and is intended for every grade of electrical work where perfect insulation and great durability is required. It is impervious to acids, alkalies or salines, and is not affected by climatic changes. Wood, paper and other inflammable materials dipped into the paint were made absolutely fireproof, and where asbestos was brought to a white heat the paint was not affected.

A coil of ordinary magnet wire on a wooden spool was subjected to 2,800 degrees of heat for several minutes, and when the paint was scraped off, when soft, the insulation was found to be entirely unharmed. A severity of the test may be judged from the fact that a copper wire was melted in less time under the same conditions. Mr. Elmer Morris, for many years well known in electrical circles, is the moving spirit in the present enterprise.

The Perkins Electric Switch Manufacturing Company, of Hartford, Conn., made an attractive showing of their large line of specialties, including switches, sockets, cut-outs, receptacles, etc., and the well-known Waterhouse Arc Lamp in ornamental designs. J. J. Gates being in charge, assisted by G. W. Conover, of Chicago, it is needless to say the interests of the Perkins company were well looked after.

The Jewell Belting Company, of Hartford, exhibited a handsome working model showing the effect of their pulley covering in preventing slipping of belts and consequent loss of power. This important feature was thoroughly demonstrated to the satisfaction of all interested. Charles E. Newton and Charles L. Tolles represented the Jewell Company as only they can.

The Belknap Motor Company, of Portland, Maine, had an illuminated exhibit and line of woven wire and graphite brushes and holders. They were represented by R. B. Smith of the Philadelphia office.

The Electric Appliance Company, of Chicago, showed a line of safety cut-outs, indestructible transformers running with case three-quarters full of water, and a full line of Packard lamps from six to 500 candle-power. The Packard focusing outfit was also displayed. The exhibit was in charge of W. W. Low, and W. D. and J. W. Packard, and C. J. Wells were also present.

The Bryant Electric Company, of Bridgeport, Conn., displayed a full line of their many specialties and were represented by T. G. Grier, one of the managers of the western office. Mr. Grier accounted for the absence of his brother by stating that it was necessary for him to remain in Chicago to handle convention orders.

The Cutler-Hammer Manufacturing Company, represented by H. H. Cutler, of Chicago, displayed a handsome line of rheostats, dynamo field regulators and storage battery accessories.

The Cutter Electrical Manufacturing Company, of Philadelphia, showed a line of circuit breakers, fuse blocks, flush switches, etc. Henry B. Cutter, president and general manager, and Walter E. Harrington, electrical engineer, were present.

The Electric Engineering and Supply Company, of Syracuse, New York, exhibited a beautiful example of switchboard work in brass and marble mounted with a complete outfit of switches and instruments, as well as a large assortment of miscellaneous small switches and cut-outs. They were represented by H. C. Hodgkins, president, J. L. Hines, superintendent, J. McIntyre and C. D. Riggs.

Heubel & Manger, of Brooklyn, N. Y., were represented by W. W. McChesney, Jr., and showed an extensive line of electric bells, push buttons, annunciators and leather boxes.

The Diamond Electric Company, of Chicago, exhibited their new Scheffer recording wattmeter, which, it is claimed, contains many valuable features. One of these is that there is no winding on the armature, no commutator and no brushes. The armature shell is one piece of spun aluminum, as is also the retarding disk. The instrument is operated entirely by induction, and is equally accurate under a load of one-eighth candle-power lamp up to the full capacity. This is true of any size meter. They are manufactured for 50 or 100-volt circuits and up to 300 lights capacity. The representative were A. M. Searles and H. B. Warren.

The Wagner Electric Manufacturing Company, of St. Louis, Mo., showed some samples of high potential brake switches and high potential line switches, ornamental economy coils, transformers, showing old and new way of erecting, the latter being a great saving of expense in construction, and combining a fuse block which will not hold an arc on 500 volts. They were represented by H. A. Wagner, E. H. Abadie and John Mustard, Philadelphia agent.

Joseph Sachs was on hand as representative of Rossiter & MacGovern, the Solar Arc Lamp Company, McCreary Electrical Supply Company and the D. Van Nostrand Company, all of New York. Samples of the goods of each of these concerns were exhibited.

Mr. William H. McKinlock, president of the Metropolitan Electric Company, Chicago, knew everybody, and everybody knew him.

The Helios Electric Company, of Philadelphia, displayed a line of their alternating and direct current lamps, with focusing attachments, showing the craters in the carbons and the action of the arc in stereopticon form. This proved very interesting, and attracted many spectators. Frank S. Marr and Thomas Spencer were in attendance.

The Manhattan General Construction Company, of 50 Broadway, New York, made the finest and most comprehensive arc lamp exhibit of the convention, and their quarters in the exhibition hall, and the lamps installed in various parts of the hotel, were objects of very general admiration. The lamps themselves were all that could be desired in the line of illumination, and the design of the fixtures was both artistic and unique. Among them was a combination arc and gas fixture of striking appearance which hung in the lobby of the ladies' entrance, and several drop lamps in the main foyer and reading room. A very striking feature was a cluster of five lamps on one fixture, the workmanship and finish of which was superb. The Manhattan lamp burns from 100 to 150 hours with one pair of carbons and without attention of any kind. Another salient point is that these lamps burn singly on any circuit of from 90 to 130 volts, instead of two in series, as in the case of all other incandescent arcs. This offers the user advantages which he will readily appreciate. The representatives of the Manhattan company were F. H. Prentiss, president; S. Marsh Young, vice-president and general manager; Stewart W. Wise and William Jandus, under whose patents the lamps are manufactured.

Mr. P. M. McLaren, of the Abendroth & Root Manufacturing Company, New York, was present in the interests of the well-known and popular "Root" Water Tube Boilers.

Mr. Charles H. Herrick had in his possession some new switch specialties made by the W. S. Hill Electric Company, of Boston.

Mr. Edward H. Phipps, president of the Connecticut Pipe Manufacturing Company, of New Haven, Conn., talked entertainingly about his company's well-known cement lined steel types for underground conduits.

Mr. Frank R. Colvin, president of the Interior Telephone Company, New York, renewed many old acquaintances among the delegates, all of whom were glad to hear of the success of the Colvin telephone system. The Colvin system of interior telephones has already been installed in over 300 buildings.

The National Conduit Manufacturing Company, of New York, was represented by Messrs. C. Gallagher, vice-president, and James P. McQuaide, secretary and treasurer. Their arguments for the advantages of their underground conduits were backed up by their convincing records of past successes.

Mr. George A. McKinlock, president of the Central Electric Company, Chicago, represented this well-known concern in his usual dignified and cheerful manner.

Messrs. James W. Godfrey and Frank W. Harrington, of the India Rubber and Gutta Percha Insulating Company, New York, did their usual effective work for the Habirshaw wires and cables.

Mr. H. E. Webb was in evidence as the representative of the Solar

Carbon and Manufacturing Company, of Pittsburgh, manufacturers of carbon specialties.

The American Electrical Works, of Providence, R. I., were effectively and efficiently represented by Messrs. P. C. Ackerman, of the New York office, and F. E. Donohoe, of the Chicago office.

The Falls Rivet and Machine Company, Cuyahoga Falls, Ohio, manufacturers of friction clutches and power appliances in general use in central stations, were effectually represented by Messrs. Babcock, Charles Babcock and H. Stambaugh.

Capt. Willard L. Candee and Mr. George T. Manson, of the Okonite Company, Limited, 13 Park Row, New York, were present and inseparable. Both these gentlemen made and received many calls.

The Standard Underground Cable Company entrusted its interests to the ability of these gentlemen: J. W. Marsh, vice-president and general manager, Pittsburgh; G. L. Wiley, Eastern manager, *Times* Building, New York; J. R. Wiley, Western manager, the Rookery, Chicago, and H. W. Fisher, electrician, Pittsburgh. Mr. J. R. Wiley, the new Western manager, was recently assigned this office vice the late Fred. W. Degenhardt. The company's headquarters were in parlors 236 and 237 on the second floor of the Hollenden.

Belden & Seely, contractors, of Syracuse, N. Y., were represented by both partners of the concern. Mr. John A. Seely took his usual active part in the proceedings of the association, and Mr. Belden made many new friends among the delegates.

Senator Fred W. Royce, of Royce & Marean, electrical supplies, Washington, D. C., was on hand, chock full of new stories and experiences.

Mr. W. B. Cleveland, of the Forest City Electric Works, Cleveland, Ohio, had many inquiries regarding the new "roll drop" commutator bars.

Mr. R. B. Corey, of New York, the well-known specialist in incandescent arc lamps, arrived late Wednesday evening and received a warm welcome from a large party of friends.

Master of transportation C. O. Baker, Jr., received a particularly sincere number of cordial congratulations on the special train which carried the New York party. Mr. Baker also rendered valuable and prompt services in compelling the Lake Shore road to furnish proper facilities for the return trip.

Professor Sidney H. Short, of the Walker Manufacturing Company, was present and renewed many old acquaintances. Mrs. Short's hospitality to the visiting ladies was much appreciated.

The Boston delegates who reached Albany early Monday morning were handsomely entertained by the General Electric Company at Schenectady pending the arrival of the New York special train.

The General Electric Company's Exhibit at Cleveland.

The General Electric Company's exhibit was the most complete and comprehensive made at the electric light convention. It occupied the entire second floor of the station of the Cleveland Illuminating Company, located in the handsome new building on Canal street, and, besides a display of supplies, was principally devoted to a working exemplification of the operation of the monocyclic system.

Arranged in a line down the center of the room was a complete monocyclic plant, consisting of a 60 kilowatt, 60 cycle monocyclic generator running at 900 revolutions and furnishing current to induction motors, incandescent lamps and arc lamps. The generator was driven by belt from a 50-kilowatt 230-volt four-pole slow-speed direct-current motor of the type which the General Electric Company has recently developed, and in which it has embodied many important improvements. This motor was driven by direct current taken from the circuits of the Cleveland Illuminating Company.

Current for the monocyclic generator at 1,040 volts was taken through two 7,500 watt transformers to a 15 kilowatt induction motor, also running at 900 revolutions, and this in turn was belted to an Edison bi-polar 12 kilowatt generator supplying direct current to a number of incandescent and arc lamps, the latter of the already well-known Thomson '93 type. The straight current from the monocyclic generator was led through a 1,000 watt and a 15,000 watt transformer to a number of incandescent lamps and Thomson '93 alternating arc lamps, and these burned brightly and without flicker. In addition a five horse-power induction motor was also driven by current from the monocyclic generator—the current in each case being measured by a Thomson recording wattmeter.

The system was thus shown to the delegates in detail and proved to their satisfaction the claims made for it, that it solved the problem of operating lights and motors of a perfect type from a single alternating generator.

A small two horse-power direct current motor of a new and peculiarly compact design was also shown in operation, and its small size and efficiency attracted considerable attention.

Two handsome alternating focusing arc lamps and two direct current focusing arc lamps were also to be seen lending their light to increase the brilliancy of the surroundings of the exhibit. The alternating current used was taken from the primaries of the illuminating company.

The exhibit of lighting supplies occupied the end of the room back of the plant. It comprised a fine display of the porcelain specialties, switches, cut-outs, etc., manufactured by the General Electric Company at its own works; a complete line of punched clip station switches, primary alternating, railway, power and direct current, two wire and three wire recording wattmeters, several of which were in operation, an arc wattmeter and a Thomson portable ammeter. In addition, a supply of the new General Electric key sockets, with porcelain bases, was shown, and one was bestowed as a souvenir to each of the visiting delegates. The exhibit was rounded off by a handsome specimen of railway switchboard work, the controlling instruments being mounted on a fine panel of Tennessee marble and by a 12-inch search-light projector. Visitors were taken to the exhibit in conveyances furnished by the company, and had an opportunity of inspecting at the same time one of the latest direct connected central stations—that just erected by the Cleveland Illuminating Company.

At the headquarters in the banquet room of the Hollenden, the General Electric Company had a complete supply of the catalogues and pamphlets for the visiting members to take home with them and study at their leisure, and an elaborate display of decorative, miniature and candelabra lamps.

On the second day of the session an informal reception was held in the banquet room and was, for the time being, the center of attraction from which the ladies departed loaded with flowers, and the gentlemen with good cigars. On Thursday morning the ladies availed themselves of the company's invitation to visit the station of the Cleveland Illuminating Company and view the exhibit.

Altogether, by the united efforts of the Cleveland Illuminating Company and the General Electric Company, the visitors were provided with an especially instructive exhibit, such as has never before been made at any previous meeting of the National Electric Light Association by any manufacturing company. The representatives of the General Electric Company were Prof. Elihu Thomson, and Messrs. S. D. Greene, E. W. Rice, Jr., Charles P. Steinmetz, Dr. Louis Bell, J. R. Lovejoy, B. E. Sunny, W. L. R. Emmet, A. D. Page, Wilson S. Howell, C. D. Haskins, H. C. Wirt, under whose special care the exhibit was installed; W. F. Hays, T. Beran, F. M. Kimball, C. E. Harthan, G. F. Rosenthal, L. D. Tandy, Edgar Mix, Bostwick, Bendow and Greenwood.

The First Direct Connected Arc Light Plant in the United States.

A brief notice was published in the ELECTRICAL REVIEW a short time since announcing the fact of the starting of the only direct connected arc light plant in the United States. A power house has been erected by the Mutual Electric Light and Power Company in Chicago, at Eighty-ninth and Loomis streets, the name of the station being Brainard, which is located on a branch of the Chicago, Rock Island and Peoria Railroad, about one mile from South Englewood station. The building is 90x110 and is substantially built with the very best of modern construction—brick walls, terra cotta trimmings and iron roof.

The plant at present includes three 125 light Brush arc dynamos connected direct to three F. F. F. Willans engines. Brush-Adams 2,000 candle-power arc lamps are used. Two 3,000 horse-power water tube boilers furnish the steam power.

The first arc dynamos ever constructed were operated at something over a thousand revolutions per minute. At that time the maximum speed of engines suitable for operating such dynamos was not over 250 revolutions per minute. Since that time the size of the dynamo has gradually increased, the speed has decreased, while the engine builder has been busy in perfecting his engine in order that it might be operated at a greater speed with the proper economy. It was in the early days, of course, necessary not only to employ belting, but in some cases countershafting to cause dynamo and engine to meet on the common ground of economy. It has been a long ways from the dynamo to the engine. In reality they were not more than 25 feet apart, but they have been 15 years approaching each other, and now at last they are together. They rest peacefully on one bed-plate, four feet two inches by ten feet three inches. The shaft of the Willans engine is connected directly to the shaft of the dynamo by means of an insulated brotherhood coupling. The speed is 500 revolutions per minute. The manufacturers of the Willans engine have guaranteed as low as 21 pounds of water per horse-power per hour, and expect to show even better results than this when final tests are made.

The first dynamo was started on the night of December 17, 1894. The start was made without a hitch, and 15 minutes after the first revolution the entire load of 125 lamps was thrown on and continued to operate for the balance of the evening. The automatic regulator of the dynamo regulates so closely that any number of lights may be thrown on or off at will and the brushes are shifted, while at the same time the current is shunted in the fields, thus providing an absolutely perfect automatic regulation. The engine is very quick to govern, easily taking care of its end of the business, and thus the two work in perfect harmony and with economy, the amount of steam used being always proportionate to the load.

The electric plant was installed by Mr. J. B. McKeown, one of the Brush Electric Company's best experts. The three dynamos and engines have been in operation some little time, the last pair being put in operation about the middle of January.

The pole line was constructed under the direct supervision of Mr. A. M. Thurlby who has had an extensive and valuable experience in the construction of electric light plants. No better test of the character and stability of his work could have been made than the severe storms which have occurred during the last few weeks. Mr. Thurlby undertook to construct a pole line which would obviate many if not all of the difficulties heretofore experienced from extreme conditions of weather. He adopted what is known as head guying. The poles are 40 and 50 feet in length and seven inches at the top. Twenty miles of No. 4 iron wire were used in guying. Securely fastening a wire to the top of one pole it was run to the next pole, 125 feet distant, and tied to this second pole at a point about 12 feet from the ground. Next a piece of similar wire was fastened to pole No. 2 at the top and run back to pole No. 1, to which it was tied 12 feet from the ground. This method of construction was carried out over the entire 17 miles of pole line, and all strain on the poles is thereby equalized and no undue strains of any character are put upon the copper wire.

The dynamo room proper is approximately 40x100 feet. Allowing ample room for moving around and between the different pairs one 2,000 candle-power arc lamp can be produced upon one square foot of floor space. A dynamo room 40x60 feet, therefore, allows the installation of a plant having a capacity of two thousand four hundred 2,000 candle-power arc lights. This is such an innovation in the progress of economy of floor space that its earnest consideration will probably change the character of all future arc lighting stations, especially in cities where real estate is valuable. A space of four feet has been left between the floor of the dynamo room and the ground, which provides a convenient place for running wires from dynamos to switchboard and steam pipe from engine to heaters. This arrangement also provides a very easy method of installing additional pairs.

Great credit for the successful starting of this enterprise is due to Mr. Arthur D. Rich, the treasurer of the company, who has stood by it under the many and various vicissitudes through which a young corporation, competing with older institutions already in the field, must necessarily pass.